SCIENCE

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SCIENCE AND PRACTISE[1]

THE Society of Naturalists at this meeting celebrates its thirtieth anniversary, an occasion which in itself perhaps calls for no special felicitation, but one on which we should all rejoice on account of the safe passing of a crisis in its life. Not many years ago its very existence was threatened, and now the society finds itself securely established for a definite purpose. Conceived by its founders as a means to bring together workers in biology for the discussion of topics of common interest, it was confronted almost at the outset by a condition in which there appeared to be no such topics, so rapidly did the organization of more special societies from its midst take place. It seemed as if its career were to be that of the ephemerid, a sacrifice to its own fecundity. Ultimately, however, as a result of an experiment suggested by the late Professor Penhallow, when president of the society, a process of regeneration took place, not an exact restitution of all that had been lost by autotomy, but rather a sort of heteromorphic growth, which, while preserving the old shell, transformed the main functional activity of the organism to a new sphere, specialized but nevertheless having much common ground of interest. It is particularly appropriate that the society should have taken up the field of genetics as its own, for what has its career been but one long persistent effort in practical eugenics? Though its early experiences did seem to resemble a self-destroying schizogony, we now look upon

[1] Address of the president of the American Society of Naturalists, Philadelphia, 1913.

them as the more usual type of parenthood. Its offspring have become many and waxed strong. The eldest daughters have begun to reproduce their kind and just to-day the society rejoices in the advent of a new grandchild.[2] We can see long vistas of new physiological associations reaching out into the dim and distant future, and no one can predict where this propagation of societies will end. We view this with equanimity so long as the new organizations do not become too narrow in their interests and so long as they continue to recognize the mutual benefits of regular family reunions. From this year's gathering the society notes with regret the absence of some of its most fancied children.

Through its relationship to the affiliated societies the Society of Naturalists has now come to represent in a general way the interests of biological science. It is important that there should be some such body in existence even if it were solely for the maintenance of the proper relationship between our science and the public.

In these days of intense practical activity and social unrest it is difficult to overestimate the need for the application of science to every-day life and to the sudden exigencies of our social organization. I do not mean merely the application of science to industry or to physical health, but rather the more general relation of science to human aspirations and to human conduct.

Man to-day, while still retaining instincts which he shares with other animals, is distinguished from them by the vast modifications which accumulated experience has brought about. Social, moral and religious sanctions are so interwoven with instinctive impulses that it is all but impossible to distinguish between what is nature and what is nurture in our make-up. Yet this is the fundamental criterion for all action that seeks to improve mankind either through breeding a better race or through the modification of his behavior.

Human civilization has its many visible signs in the machinery it employs and in the objects it collects about it. These are the outward expressions of the mental and moral impulses that have actuated man and which we collectively call culture. Many definitions of this elusive spirit have been attempted, but I like best Matthew Arnold's characterization, that culture has its origin in the love of perfection, and involves two main elements—the passion for knowledge and the will to do good. It rests upon right thinking as well as upon right doing—I like this conception because it recognizes culture as creative, and not merely as passive appreciation.

> To give these forces [of culture] names from the two races of men who have supplied the most signal and splendid manifestation of them, we may call them respectively the forces of Hebraism and Hellenism. Hebraism and Hellenism—between these two points of influence moves our world. At one time it feels more powerfully the attraction of one of them, at another time of the other; and it ought to be, though it never is, evenly and happily balanced betwen them. . . . The governing idea of Hellenism is *spontaneity of consciousness;* that of Hebraism, *strictness of conscience.*[3]

Science, like literature, art and other instruments of culture, has fallen under both of these influences. Yet science in its last analysis is the very embodiment of the Hellenic spirit—the passion to know. Its great intellectual achievements are the fruition of this ideal. The application of these to the alleviation of human misery and the uplift of the world are manifestations of the spirit of Hebraism.

The commonest and the most distorted

[2] The American Society for Experimental Pathology.

[3] "Culture and Anarchy," pp. 110 and 113.

view of the value of science finds utterance in the glorification of its relation to mechanical invention and industry in general. I am not one of those who believe that science has been sullied by this alliance, but I do wish to emphasize the one-sidedness of this point of view. These improvements are applications of science. They have given us much comfort and ease, and they have suggested some of the most interesting fields for purely scientific study though, on the other hand, they have brought in their wake some of the most difficult problems with which society is confronted. However, it is not the material benefits that man now most needs. In these days when most perplexing questions are crowding upon us, it is not so much the results of science as it is the spirit of scientific inquiry and the application of scientific method that are indispensable. To have an array of investigators covering all fields of human knowledge is not sufficient. What is most needed is that the scientific spirit should permeate much further into the rank and file of humanity, that there should be a more general appreciation of the value of science beyond what it does for our bodily comfort.

It is not necessary to dwell at length upon what constitutes the spirit of science and what its methods are. Accuracy in observing and recording natural events is the very foundation of its existence; power of analysis, sense of proportion of values, and imagination are necessary for its highest achievements. The watchword of science is fair play and fearlessness in recognizing that the rules of the game are inexorable and that any infraction of them leads sooner or later to disaster. It is too much to expect the man in the street to possess scientific imagination and subtle analytic power, but it is not beyond reason to hope that there may be found in him ultimately a greater regard for accuracy and fair play in forming opinions to guide his conduct.

Modern life is, however, not satisfied with opinions—we have them to satiety. It demands action as well as words. This restless demand for action reveals undiscriminating and half-baked opinions, and it leads to one individual demanding that others make their own conduct conform to what he thinks is right.

We are just now in a period of exuberant Hebraism. At least at the present time the Hebraic ideal seems to be the dominant if not the only uplifting force opposing the most sordid materialism. But we need more light—we are in sad need of the genius of Hellenism in general affairs. It is the part of science to breathe this spirit, to provide the basis of action that is right and to discourage doing for the mere sake of doing. If, though, practical life has too much of Hebraism, the very best of science is too much without it. Scientific men must take greater part in the affairs of the world, not only in industry, but also in the idealistic movements of society. The unrelenting abomination of sham, hypocrisy and wilful ignorance which inheres in science means far more for mankind than the solution of particular problems. Who, for instance, would place the chief value of astronomy in its application to the art of navigation, to surveying, or to the prognostication of the weather, rather than in what it has done in widening man's horizon and giving right appreciation of the relation of himself and the earth to the universe? The sublime ideas of infinity of space and time and the beauty of the simple laws of planetary motion have had a value to mankind far transcending that of any so-called practical application of stellar science. The theory of evolution is in the eyes of the mul-

titude a totally unpractical idea. Yet it has done more to stir the foundations of society than the steam-engine or the telegraph.

The failure of scientific men to exert their full measure of influence in affairs rests largely upon their guilelessness and naiveté in dealing with men as well as upon their natural reluctance to express opinions on subjects about which they feel they know but little, especially since the problems involved are usually of far greater complexity than those encountered in their regular work. You will see that I am overcoming that reluctance this evening.

Society, maintaining itself upon an incomplete knowledge, which is always in process of growing, must necessarily at times receive rude shocks and make new adjustments. Just at present all its constants seem to have become independent variables. Old traditions have given way and doing is preferred to thinking. To be called a man of action is to receive the highest approbation of one's fellow-men. Yet there never was an age when there was greater need for sound thinking.

The pressing problems all involve in their last analysis the relation of the individual to society. In how far shall liberty of the individual be subordinated to that of the community? For better or for worse the doctrine of *laissez-faire* is in abeyance. It is the abuses of individual liberty that are uppermost in men's minds, and the defense of individual rights is in danger of being left completely in the hands of those who would use them for selfish ends. The spirit of social and moral progress is ground between the upper millstone of doctrinaire reform and the nether millstone of commercialism. Many good and wise men find themselves in a dilemma from which there seems to be no way out.

The more purely economic and administrative problems need perhaps cause no great misgiving. They are likely to keep themselves adjusted to the requirements of the nation even though sharp clashes of interest do arise, for here there are more exact measures of value and a sort of self-regulating mechanism which, while it may often get out of order, nevertheless will not fail entirely. It is for the social and moral questions that solutions seem most remote and the direction of travel most uncertain.

In this age of militant reform the list of measures proposed for the regeneration of mankind and for which organized propaganda is made is a very formidable one. Effort is correspondingly scattered and really important movements are befogged in a cloud of petty and oft ill-advised attempts at correction. Reformers are good citizens with the best of intentions and are frequently the sole influence for good in a community. The evils which they combat are often very serious, so that one hesitates to do or say anything in opposition to their aims, or even to the means they employ to realize them. Yet there are weighty and by no means selfish considerations that may constrain one at times to raise a dissenting voice and draw attention to some of their misdirected efforts.

The chief characteristic of reform is the dominance of Hebraism over Hellenism—"the preference of doing to thinking." It is always ready to act, and to act with enthusiasm according to what it supposes to be light, though half the time remaining blind to the need of more knowledge and neglecting the means of obtaining it. There is neither breadth of view nor sense of the proportionate value of things.

Particularly misguided are those reforms that seek to enforce by legal enact-

ment various forms of abstinence, that empty sort of moral felicity the real virtue of which consists in the circumstance that it may be followed later by some properly regulated and supposedly innocuous indulgence. The prohibition movement is the best to consider here by way of example because it is one of great force and one that aims to combat a serious evil. Any argument that is valid against it will hold *a fortiori* against similar movements.

The misery caused by drink, with all its hygienic, economic and moral phases, appeals dramatically to man's sympathy and awakens the desire to do something to mitigate it. To accomplish this no means would seem simpler and more direct than the prohibition of the sale of liquor by law. The results of this method have not been satisfactory, however, except perhaps in small communities, because the habits of mankind involved are treated merely as so many physical obstacles to be thrust aside by a calculated amount of force. It is not reasonable to expect that a large minority—within a fraction of fifty per cent. in the state of Maine—will submit to the regulation of their personal habits by scarcely more numerous neighbors. Not having the moral support of a large enough proportion of the population, the laws are violated to a scandalous degree. Thus, while the intent of the prohibition laws constitutes an unjust infringement of individual rights, their failure to accomplish their purpose, which is inevitable, is responsible for evils far more fundamental and more insidious than the drink habit itself. This is realized by a great many thoughtful persons but, incredible as it may seem, opposition to the propaganda of prohibition is left largely to those pecuniarily interested in keeping the liquor traffic intact. There are certainly some most exasperating and disheartening aspects of the liquor situation in this country—so many, in fact, that worthy citizens sit in their clubs and drink, at the same time giving a long list of reasons why they vote "no license." Nevertheless a large proportion of these evil features could readily be eradicated if we had less of that hypocrisy and cynical contempt for the law that is engendered by the existence of so many laws not really in accordance with public opinion. The experience of other countries amply justifies this view.

The methods employed to obtain prohibition legislation are often more objectionable than the measures themselves. Public opinion is aroused by protracted campaigns led by paid agitators, where enthusiasm for the cause precludes all consideration for opposing views and the rights of the minority. The legislative chambers become invaded by a veritable lobby of political and moral intimidation, and the final passage of an act is made the occasion of scenes that belong to the time of the crusades rather than to the present. Even the halls of the national congress are not exempt from such spectacles,[4] and yet those who believe that important questions should be settled with full knowledge and in a fair and dispassionate spirit stand aside and leave the opposing ground to the brewery and the saloon. To tolerate such methods for accomplishing even the most worthy purpose constitutes the gravest kind of danger to our political and social organization. The pernicious habit once acquired will surely be used for baser ends. The art of exhortation is confined neither to the righteous nor to the wise, and much, if not all, of what is done by the revivalist method will inevitably be regretted in the light of reason and have to be undone—often with difficulty.

To attempt to stop drinking by legal

[4] December 11, 1913.

compulsion is to overlook that behind the tangible evils of drink there lies a weakness of human character. It is but the part of foresight to look to influences that strengthen self-control rather than to remove some particular temptation. The latter action substitutes the restraint from without for the far more ennobling and enduring restraint from within. Man is too much of an imitator not to have his individual character deeply modified by environmental influences. The force of a good and cheerful example will accomplish more than preaching and artificial restraint. All can not be saved, but it were better that some go to the wall than that all sicken in that stifling air of virtue by act of legislature.

Almost daily some new "crusade" is chronicled. Some are directed against real evils, others are trivial and still others vicious. These reform movements, so far as they seek to regulate the private life of individuals, show weaknesses of the same kind as those just cited and probably none of them has the justification that the drink evil affords. More sound thought and less hasty action is needed. Let there be less running to the legislature for laws that make new crimes of venial offences, and laws that extend the definition of serious crimes to include lesser transgressions. Undue severity of punishment, instead of stopping crime and immorality, merely brings the law into discredit. "If we inquire into the cause of all human corruptions," wrote Montesquieu in "The Spirit of Laws," "we shall find that they proceed from the impunity of criminals, and not from the moderation of punishments. Let us follow nature, who has given shame to man for his scourge; and let the heaviest part of the punishment be the infamy attending it."[5] If this be true for major crimes, and the Romans at least found that it was, how much more does it hold for those very natural offences against good behavior that moral zealots seek to punish with severe penalties. But, I fear, such wisdom is a long way off from general recognition in this country, for, as Mr. Bryce pertinently remarks, "For crotchet-mongers as well as for intriguers there is no such paradise as the lobby of a state legislature." Lest this seem far away from science, remember that the method of science is based on experience. Shall we throw all past experience to the winds in our mad dash for the millennium?

The youngest reform movement, as yet but scarcely born, the one which all biologists must be watching with parental solicitude, is eugenics. But this youngster, too, needs protection from its overzealous friends. Already the enthusiasts are demanding legislation, unmindful of how little information we really have to base it on, and oblivious of the vast complications of a problem which touches the very vitals of our social and our animal organization. For the present the practical application of eugenics to man would best be left to that minority of thoughtful and rather unimpulsive persons who are willing to experiment upon themselves and their descendants. On the other hand, we need not look upon the widest extension of this practise with any misgiving. The eugenic sanction, even if it does require the subordination of the impulse of the moment to future expectations, is far less artificial than many of the restraints imposed by our present social conventions.[6] In considering the motives that may impel mankind in the future to more general practise of eugenics, it does not seem likely that young men and wo-

[5] *Op. cit.*, Vol. 1, p. 96. Nugent's translation.

[6] Havelock Ellis, "The Task of Social Hygiene."

men will be carried away to any extent by a higher sense of duty toward remote posterity. The ideal will be realized rather through the due appreciation of a fragment of ancient wisdom: "The father of the righteous shall greatly rejoice; and he that begetteth a wise child shall have joy of him"—Hellenic sense from a Hebraic source.

Holding the view that many of the tendencies of the time may best be combated by more general use of the methods of science, and by less worship of material results, it is pertinent to inquire how to make the scientific attitude of mind more prevalent. Here the immediate problem is not one of eugenics. Even for the present generation and the one following it we hope to do something through individual training.

Our own time has witnessed the extensive introduction of science teaching into the schools and there are now no important institutions of collegiate rank in this country where science is not at least on an equality with the humanities. As a consequence of this we should expect more satisfactory results than have been obtained. The fault is that in our science teaching too much stress is laid upon the mere imparting of information, in response to the demand that subjects must be presented in an attractive and entertaining way, and in disregard of the fact that the chief value of science lies in its methods and its spirit. We do not make enough of methods and thoroughness. School and college science is much too desultory; there is no practise in that power of sustained thought that is so necessary to the drawing of right conclusions. In the schools there are possibly difficulties in the way of concentration of studies, but it is by no means so in the colleges, and such concentration is at present hindered only by the time-worn notion that culture consists in knowing a little about everything. Specialization has been forced upon us by an unprecedented activity in all branches of learning. Not to plan our curriculum in accordance with this condition is futile. If we want men who can direct their attention to the solution of the large problems of life we must give our youths practise in concentration of thought—some rigorous schooling in the methods of reasoning by which problems are solved. One who has had such training, no matter in what subject, will have no difficulty in picking up any information he may need, but the man who has scattered his efforts will ever flounder hopelessly and will find his appetite for sound learning dulled by his persistent nibbling.

This leads to the general question of the value of discipline, a feature of training sadly lacking in our American life. We indulge our children at home, we demand no mark of respect from them, we give way in deference to all their whims, and we are pleased to see them entertained rather than instructed and trained in our schools; and on top of all of this unwise and unfitting early training it is sought to reform the world by laws that require the most self-denying conduct. Are we not trying to "teach the old dogs new tricks"—an impossibility known to the world long before the study of animal behavior became a science? Could not infinitely more be accomplished by a rigorous early training? Good habits acquired in early life would surely obviate the ground for much of that clamor for compulsion at a period of life when compulsion comes hard.

If our educational system and our family training do not altogether measure up to their opportunities in bringing more of the scientific spirit into life, what shall we say of the relations of our agents of

publicity to the problem? If the masses are not reached in the schools they may be reached through the newspaper, but at present the relation of science to the press is in a lamentable state. Especially in this country, where we pride ourselves on the freedom, the enterprise and the versatility of the daily newspaper, the relation is particularly unsatisfying to scientific men, and altogether ineffective as a means of properly interesting and informing the public on scientific progress. Probably the fault lies on both sides. The press, in catering to the popular taste for the sensational and in disregarding the very foundation of scientific inquiry, which is accuracy, utterly fails to reflect the purpose and the results of scientific activity. On the other hand, men of science hold themselves aloof, and do not appreciate their opportunity to exert a useful influence. It may be that the latter is the real root of the evil. In any case, it is at this end of the line that we ourselves may best try to help out. It is true that the limited experience which members of our profession have had in the matter of newspaper publicity does not lend much encouragement to the hope of a satisfactory outcome. Some of the most influential dailies avowedly have the desire to promote the true interests of science in relation to the public welfare; they have the confidence of some scientific men, and often have direct access to the sources of discovery, but what one of us can be satisfied with the form in which new discoveries are reported? We can not, of course, expect statements of our work to command the attention of the public if couched in the language of the *Jahresbericht*. Explanatory matter must be given, but beyond the demand of a diseased taste for the sensational, is there any necessity for the form in which science is now presented in the newspapers? Must a discovery, in order to attract notice, necessarily be heralded in flaring headlines as the greatest of the day and be accompanied by a full-page portrait of the discoverer? Yet that is the kind of science given to the newspaper-reading public to quench its thirst for knowledge.

Each year there are held in this country, not to speak of the world at large, numerous scientific congresses, at which much is communicated that is of the utmost importance to civilization. We should expect to find the proceedings adequately and decently reported in the newspapers. That this expectation is vain, is, however, obvious. To relate a little experience of my own will serve to answer why it is so. A few minutes before being called upon to speak at a medical congress not long ago, I was approached by a reporter who asked for an account of my paper. My remonstrance that he could soon hear what was to be said to the assembly, evoked the reply that he hadn't time for that and, besides, he wouldn't be able to understand if he had. Immediately after the meeting another reporter came up and asked me to explain the papers that had been read, and particularly what was meant by the terms "tissue," "cell" and "heart-beat," confessing frankly that he hadn't understood a word of what had been said.

Clearly there is no reason to find fault with either of these men for their ignorance. They may have been quite competent in their regular work. They certainly had the virtues of frankness and of knowing their own limitations. It would be unreasonable to blame a reporter of sporting or police news for a lack of knowledge of radio-activity or experimental embryology, but what should we say of otherwise resourceful newspapers that send such men to report scientific news for a knowledge-craving and credu-

lous public? That such subjects can be sensibly and accurately reported in the daily press is proved by the splendid record of the London *Times*, as shown, for instance, in its admirable reports of the last International Medical Congress. These reports have almost the accuracy that one would expect to find in official proceedings of the meetings. It is clear that the meetings were reported by experts, not only possessed of requisite knowledge, but also highly skilled in the art of writing. Here is an example worthy of emulation, and a splendid opportunity for some of our best papers to serve the public interest.

We read the newspapers and furthermore we believe what we read more than we are willing to admit, though we damn them and sneer at them at the same time. But it is wrong to say that conditions are hopeless and incapable of betterment. Improvement in the relations between science and the press can be effected through closer contact and understanding. Scientific men must emerge occasionally from the sanctum and endeavor to make their aims and their work understood. The press for its part must in reporting science give up catering to the public demand for the sensational, and allow itself to be inoculated by the germs of accuracy and honesty that give life to the scientific spirit. The scientific man must not be pictured as an alchemist in medieval surroundings, searching for the elixir of life or the philosopher's stone. He is both human and modern, and the public will learn to appreciate him sooner as a man than as a magician. The habit set by reporting science in the spirit of science would ultimately spread to the more usual fields of newspaper activity and lead to more accuracy and less desire simply to make a good story in reporting news. This and a more rational conception of what science stands for and what its methods are will give to the average man the power to view his own problems with sanity and clearness and discredit a large measure of the cant that now gains many followers.

In giving expression to belief in the signal importance of the scientific spirit for practical life we come inevitably to those questions which every one has asked and no one has answered. Whither is it all leading, and how is it going to satisfy our human yearnings? It has been often said, and correctly, that we, the philosopher-scientists of to-day, have but traveled as did the poet-astronomer eight hundred years ago.

> And many a Knot unravell'd by the road;
> But not the Master-Knot of Human Fate.

But need this observation in its modern application be interpreted as a wail of pessimism? I think not. Though modern science has not pretended and does not now pretend to have unraveled the master-knot, though its philosophy even shows that we can not hope to attain that goal, the unraveling of knots by the road has shown no tendency to stop and new ones are ever appearing, no matter how far we go. Every knot unraveled effects some change in the relation of man to his environment, and sooner or later calls for some act of re-adjustment on his part. In this respect the modern relation of science to practise seems to differ fundamentally from that which obtained during the period of Hindu and of Greek ascendency, and this circumstance leaves ground for hope that the civilization based upon it may long endure and escape the fate of its forerunners so well described in Huxley's words:[7]

> The Vedas and the Homeric epos set before us a world of rich and vigorous life, full of joyous fighting men
>
> "That ever with a frolic welcome took
> The thunder and the sunshine. . . ."

[7] "Evolution and Ethics."

and who were ready to brave the very Gods themselves when their blood was up. A few centuries pass away, and under the influence of civilization the descendants of these men are "sicklied o'er with the pale cast of thought"—frank pessimists or, at best, make-believe optimists. The courage of the warlike stock may be as hardly tried as before, perhaps more hardly, but the enemy is self. The hero has become a monk. The man of action is replaced by the quietist, whose highest aspiration is to be the passive instrument of the Divine Reason. By the Tiber, as by the Ganges, ethical man admits that the cosmos is too strong for him; and, destroying every bond which ties him to it by ascetic discipline, he seeks salvation in absolute renunciation.

In our present culture the passion to know and the finding of new knowledge calls forth the desire to act even though the two impulses are not always found in the same individual. The very technique of modern science requires action; ideas are followed by experiments and experiments give new ideas. Discoveries lead to inventions which revolutionize social and economic conditions. On the other hand, practical instruments have suggested some of the grandest ideas of science, as when the problem of the economy of the steam engine led to the discovery of the law of the conservation of energy; and who will set any limit to the flow of ideas set free by present social and industrial conditions? Thought and action are in an infinite alternate succession. Because of this, because of the relation of present science to every phase of life—physical, intellectual, economic, social, ethical—I believe that the love of right thinking will not endanger our will to act.

Nor is there grave danger in the determinism of science, which has proved to be such an effective weapon in the pursuit of knowledge. Present methods of investigation become impossible if not based upon the postulate of the "uniformity of nature," but, at the same time, the motive to carry out our inquiries, the passion for knowing, takes us ever to new and untrodden fields, broader and of ever increasing interest. This enormous unknown region, which renders the prediction of the remote future but idle fancy, and hems our ability to predict our own conduct even in commonplace affairs, leads us to ascribe to ourselves freedom to act as we will, and to place upon individuals a proper share of praise and blame for their acts. This feeling, which is instinctive, will not generally give way unless the time should come when all of the events of nature can be foretold with precision.

It is not my wish to indulge in the pastime of prophecy. The tendencies of the time, though in reality but ripples, may often seem like mountainous waves about to engulf all. We may consider ourselves fortunate if we can see over the crest of the nearest wave and apply our strength and skill to stem its force. The present danger is not a wave of individualism and anarchy; it is rather a perversion of moral and intellectual ideals that seeks to confine spontaneity and individuality within a pale of external restraint, to minister to all wants, to regulate all joys—in other words, to *standardize* human character, by smoothing out to monotonous level those ups and downs of life that make us what we are.

Thinking and doing are for the time out of balance. Science has the power to restore and maintain the balance by breathing more of its spirit into practical life, and if an instrument to guide this work is needed—if it is right for men of science to have a confession of faith—I know of none more inspiring than the words that Huxley used in defining his own life purpose:

To promote the increase of natural knowledge and to forward the application of scientific methods of investigation to all the problems of

life to the best of my ability, in the conviction which has grown with my growth and strengthened with my strength, that there is no alleviation for the sufferings of mankind except veracity of thought and of action, and the resolute facing of the world as it is when the garment of make-believe by which pious hands have hidden its uglier features is stripped off.

ROSS G. HARRISON

PUBLIC HEALTH EDUCATION, WITH SPECIAL REFERENCE TO THE SCHOOL FOR HEALTH OFFICERS OF HARVARD UNIVERSITY AND THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY[1]

FROM time immemorial the world has recognized three great professions—the ministry, law, medicine. They stand, respectively, for love, order and health—the great trinity upon which human happiness is founded. During the nineteenth century another profession arose, different from the other three in that it concerns itself with things external, but nevertheless of vast importance to the well being of the race—the profession of engineering. With many parts, heterogeneous, amorphous, the world has not always recognized it as a united whole; but gradually it has become crystallized around the central idea that "engineering is the application of the great forces of nature for the use and convenience of man." Thus our professional triangle has become four square and our modern civilization may be said to rest upon the four learned professions—the ministry, law, medicine, engineering.

Between these corner posts of education the framing of our social structure is intimate and complex. Beams stretch from one post to the other, and there are braces and cross-braces; combinations of sciences, sub-professions and vocations. As civilization becomes more complex the network thickens until we can scarcely recognize the boundaries of our callings and even our avocations become mixed with our vocations.

[1] Address delivered at the New York State Conference of Sanitary Officers at Saratoga, N. Y., Sept. 15, 1914.

Every once in a while some particular need of the race comes prominently to the front, and as the need becomes filled and men educate themselves for it we say a new profession has come—meaning a new species, not a genus.

At the present time the great need of the world is *peace*. The new science of engineering has built one of its structures too high and it has toppled over. Over-developed armaments have thrown the nations into a sea of blood, from which only the other three professions can rescue them, those which stand for love, order and health. But it is not civil engineering which has wrecked Europe, it is military engineering—the application of the great forces of nature not for the use and convenience of man but for the destruction of man. This is not what is meant when we speak of the new fourth great profession.

Although engineering has failed to blot out war, it has done much to blot out the other great scourges of the race—famine and pestilence. The development of transportation on land and sea has brought the wheat fields of the smiling prairie to the parched desert, and has widened the market gardens of the city. Agricultural engineering has multiplied the fruits of the soil. The development of cold storage has widened our markets in time as well as distance. Future famines from natural causes will occur only when engineering fails to do its work.

In combating pestilence the profession of engineering has combined with that of medicine. When disease comes from without it requires the aid of a profession which deals with things external, and as disease always acts within it requires the aid of a profession which deals with things internal. It is idle to discuss whether the doctor or the engineer plays the greater part in preventing disease. Where so much has been accomplished by both, where the work to be done is so great, there are tasks enough and rewards enough for both professions. In fact we must include the professions of ministry and law because social service and legal force are potent weapons in the campaign for health. Let us recognize as our first principle that the leaders in this cam-

paign, the health officers of the country, must base their work upon all four of the great professions, upon medicine, engineering, law and social service. It is for this ideal that the new School for Health Officers of Harvard University and the Massachusetts Institute of Technology stands and it is about this ideal that I wish to speak to you to-day.

The movement for fostering health and preventing premature death from accident and disease is world wide in its range, and has attained a magnificent popular momentum, thanks to thousands of earnest men and women who have approached the subject from many different angles. It is a mighty stream, and like a mighty stream has power for good and power for harm. It needs to be controlled. The movement needs to be organized through regularly constituted governmental agencies. The mechanism for this already exists in crude and diversified forms. We have departments of health in most states and cities, local boards of health in small communities, occasional county or district organizations, voluntary associations, philanthropic agencies, and last but not least our ambitious and constantly improving national Public Health Service. Without in any way belittling what is being done, on the contrary with a just pride in what has been accomplished, we must all admit that, take it the country through, the public health service is ineffectively organized and insufficiently supported. The need of the hour is for official leadership and for the public recognition of this need for official leadership.

We are all familiar with the term "captains of industry." We know that the men so called are leaders in the industrial world. But we also know that industrial organization would go to smash were it not for the sergeants of industry and for the corporals of industry, for those who come into actual contact with the rank and file of business men. Similarly we have our "captains of health." Their great names are known to us all. We recognize their ability. When they speak the world listens and takes heed. But as an organization we lack the sergeants of health and the corporals of health, we lack the local leaders.

Our present local health officers have risen from the ranks, generally from the medical profession. All honor to those who have served so faithfully and so well. Those who have succeeded and have become not only sergeants, but captains of health, have done so only by long service, individual study and personal sacrifice. Individuals here and there have succeeded, yet the method is wrong.

Our present service is unequal in efficiency. The large city, with a large problem, can afford to pay a large salary to a large man. The small town with a small problem has likewise been obliged to pay a small salary to a small man, or, to put it less harshly, to pay a small salary to some man who, because of the small salary, can not give all of his time or thought to the public health service. We also have local boards of health where no one is paid, and where the service is consequently irresponsible. A great fault is that the ultimate unit has been too small. The problem of caring for a people's health is so complicated that the man who attempts it should not try to do anything else. He can not do so in justice to himself and to his work.

In order that he may give his whole time to his job he must be paid a living wage. And in order that he may be paid a living wage he must serve a district large enough to afford such payment. Hence the ultimate unit must be made larger than it has been in the past. Improvements in transportation and the communication of thought make this possible to-day to a much greater extent than formerly. The town, or the borough, or the village, or the small city will not ordinarily prove adequate, and one of the signs of the times is the establishment of public health districts presided over by a district health officer. The state of New York has adopted this system and Massachusetts is following her example.

We also have in Massachusetts examples of voluntary combinations of neighboring towns to secure the services of a health officer who

gives his full time to the towns included in the arrangement. The towns have the advantage of the services of a specialist and the man receives joint compensation commensurate with his services.

The first step in perfecting our public health organization, therefore is to provide for full time health officers, serving districts large enough to afford an adequate salary for a well-trained man.

The second step is that of securing stability of service, by establishing long terms for health officers. To train one's self for this work costs time and money. It requires capital in the shape of education and experience. No man can afford to enter upon this career unless his livelihood is assured. Furthermore, a health officer's success does not depend wholly upon his knowledge of sanitary principles; it depends equally upon his knowledge of the community. He must know his territory geographically and physically, and he must know his people and their habits of life. This knowledge can be acquired only by familiarity.

The third step is coordination. Lines of authority should be established from the health officials of the smallest communities through the districts to the state departments of health, which in some states are already well organized. Cooperation between the states under the general direction of the federal government will also be necessary.

But let us come now to the man himself. What shall the health officer be, a doctor, an engineer, a lawyer, a minister? Yes, any one of these, provided he knows enough about the other three professions and has the proper personality. Instances may be cited where lawyers and where ministers have become public health officers, and in recent years many engineers have proved conspicuously successful in this field. It must be admitted, however, that in the majority of cases men have entered this service through the profession of medicine. This was natural and proper as long as disease was regarded as something wholly personal, and it probably will remain true that for many years to come the best portal of entry to the public health service will be that of the profession of medicine. By this is meant that the man already learned in medicine will have less to learn of the other sciences than he who is already trained in some other profession will have to learn of matters that are biological and medical. Again, the world has for so long regarded the medical practitioner as the custodian of the public health that the title of doctor carries with it a certain prestige which is of advantage from an administrative point of view.

We have seen, however, that the profession of public health has greatly broadened. Young men starting afresh for this career can not afford in most cases to become a doctor of medicine first and a doctor of public health afterwards, or an engineer first and a doctor of medicine afterwards. Also the training for the degree of M.D. contains many matters which relate to healing and have practically nothing to do with the prevention of disease. The time devoted to them can be spent to better advantage in the study of other subjects more directly connected with public health administration, such as sanitary engineering and demography.

It is a fatal mistake, therefore, to make the medical degree a prerequisite to public health positions, as it tends to disbar from the service young men who are giving themselves the broadest and best possible education for the positions that need to be filled. Some of our best and most recent laws still contain provisions for this outgrown and unfortunate limitation. The requirement of an M.D. was doubtless made in order to safeguard the service from the political appointment of unfit men, but it now needs modification in order to provide for the new conditions and to admit to the service those who are specializing in preventive medicine and the control of the public health. It is true that the harm will come in the future rather than at present, but it is the future of the service to which we should look. Laws which prescribe an M.D. degree should be amended by the addition of some such modifying clause as this—"A doctor of medicine or a person trained in public

health holding a degree or certificate in public health from a school of recognized standing." This would open the field of service to those best qualified to serve and would at the same time prevent the unscrupulous political appointment of unqualified persons.

There is an increasing number of young men who without an M.D. degree are fitting themselves for public health service. What is more they include some of the best of the college graduates, men who have come to realize that they can best serve humanity by helping to maintain humanity's health, men who are going to devote their lives to the cause. The states and cities which remove the present disbarment will get the services of these enthusiastic progressive specialists and will benefit accordingly.

Before the field of service in the public health is fully opened to men without the medical degree it is right and proper that the training which students are getting in the acquirement of a degree or certificate in public health be carefully examined to see if it is adequate. Unless the training is adequate the change in the laws should not be made. I bring before you to-day the program of studies at the School for Health Officers of Harvard University and the Massachusetts Institute of Technology—the first school of its kind in the country, trusting that it will be studied and that we may have the benefit of advice founded on experience.

The School for Health Officers is conducted by Harvard University and the Massachusetts Institute of Technology, acting in cooperation, through an administrative board appointed for this purpose, by both institutions. At the present time the board consists of Professor William T. Sedgwick, chairman, Professor Milton J. Rosenau and Professor George C. Whipple. It is significant of the spirit of the school that these men are respectively a doctor of science, a doctor of medicine and a civil engineer. Dr. Rosenau is director of the school, with headquarters at Harvard Medical School.

The principal object of the school is to prepare young men for public health work of all kinds and especially to fit them to occupy administrative and executive positions, as health officers, or members of boards of health, or secretaries, agents or inspectors of health organizations. To this end, lectures, laboratory work and other forms of instruction are offered by both institutions, and by special instructors from national, state and local health agencies. The subjects embraced in the course of study have been selected to cover a wide range, including medical, biological, hygienic and engineering sciences, together with practical health administration.

A certificate in public health (C.P.H.) is granted to candidates who have satisfactorily completed the studies in an approved schedule, who have spent not less than one academic year in residence, and who have otherwise complied with all requirements. This certificate is issued by Harvard University and the Massachusetts Institute of Technology and signed by the presidents of both institutions. The first class graduated in June, 1914, when five men received their certificates. It happened that all of these had previously received a medical degree. The membership in the school is now eleven.

The question may naturally occur to some one, why call this a certificate in public health, and not a doctor of public health, or a diploma in public health. The reason is that the degree of Dr.P.H. is already administered by Harvard University in its medical school, and stands for a larger body of work, and a longer course than most men can afford to take or than it is necessary to take in preparation for many of the positions in the public health service. The reason that the "Diploma in Public Health," *i. e.*, D.P.H. was not chosen was because these letters sometimes stand for doctor of public health and our school desired to avoid giving what might appear to be a doctor's degree, but technically was not.

The following are the requirements for admission: Graduates in Medicine of Harvard University and other recognized medical schools are admitted upon their records and registered as candidates for the certificate in public health. Bachelors of science in biology

and public health of the Massachusetts Institute of Technology and other recognized institutions are likewise admitted and registered as candidates for the certificate.

Masters of civil engineering of Harvard University who have specialized in sanitary engineering and bachelors of science in sanitary engineering of the Massachusetts Institute of Technology and other recognized institutions, who lack the necessary preparation in medical and other sciences, are admitted upon their records, but are required to spend at least one year in preparation before being accepted as candidates for the certificate in public health.

Other graduates of colleges or technical or scientific schools are admitted to the school without examination, provided their collegiate courses have included adequate instruction in physics, chemistry, biology, French and German; but, as a rule, they are required to spend two or more years in preparation before being accepted as candidates for the certificate in public health. Applications for admission to the school will be considered from those who have spent at least two years in a recognized college or technical or scientific school and have pursued satisfactory courses in physics, chemistry, biology, French and German, and also from persons of unusual experience or special qualifications; but, as a rule, such persons are required to spend two or more years in preparation before being admitted as candidates for the certificate.

Special students, not candidates for the certificate in public health, who desire to fit themselves for some special field are admitted to the school, and may take any course or courses for which they are properly qualified, on approval of the administrative board.

Women are admitted to the School for Health Officers on the same terms as men, and are equally eligible for the certificate in public health. Women are admitted to many of the courses given in the Harvard Graduate School of Medicine, but not to undergraduate courses in the Harvard Medical School. If women require the latter courses they must be obtained elsewhere, preferably before entering the School for Health Officers.

As the school is now in its infancy no uniform curriculum is required of candidates for the certificate in public health. Each student is required to choose a schedule of courses to meet his individual needs. In general, the choice of studies must be such that the candidate on the completion of his course will have covered in a broad way the subjects included in the varied duties of a public health officer, together with such allied subjects as anatomy, physiology, pathology, biological chemistry, sanitary biology, preventive medicine and hygiene, demography and sanitary engineering.

After a few years' experience it is probable that some standard curriculum will be prescribed, but the time for this has not yet arrived, as the qualifications of the average student on entrance remain to be learned. It is probable also that different standard schedules will be made for students who wish to prepare for different fields of work.

Every candidate for the certificate in public health is required to complete satisfactorily each course taken by him and, on the completion of his approved schedule, to submit to a general oral examination by the administrative board. This examination covers not only his work in the school, but his previous studies and experiences. Last year the oral examination of each student lasted at least two hours.

The courses available in the school are not restricted to those stated in the catalogue of the school, but may include subjects in any department of Harvard University or the Massachusetts Institute of Technology, provided the work is in harmony with the objects of the school and meets with the approval of the instructor in charge of the course and of the administrative board. Certain special courses are given by instructors not otherwise connected with either institution, and practical work may be taken in city, state and national health departments and in the hospitals of Boston. As time goes on it is the intention to increase the opportunities for this practical work, or apprenticeship, which obviously is an

important element in a health officers' training.

The courses offered are divided into two lists. The first is a list of so-called regular courses, which demand considerable time and ordinarily cover a half year or more. It is from this list that the student is required to make his principal selection and do his most serious work. The second is a list of special courses and lectures.

The courses are also divided into eight groups according to subject. These groups are as follows:

1. Preventive Medicine.
2. Personal Hygiene.
3. Public Health Administration.
4. Sanitary Biology and Sanitary Chemistry.
5. Special Pathology.
6. Communicable Diseases.
7. Sanitary Engineering.
8. Demography (Vital Statistics).

The following is a list of the courses offered in 1914:

REGULAR COURSES

Group I. Preventive Medicine

Principles of Sanitary Science and Public Health. Professors W. T. Sedgwick and S. M. Gunn.

Preventive Medicine and Hygiene. Professor M. J. Rosenau, Dr. L. W. Hackett, Dr. E. S. Birge and Dr. F. B. Grinnell.

Public Health Problems. Professor S. M. Gunn.

Epidemiology. Professor W. T. Sedgwick.

Relation of Animal Diseases to the Public Health. Professor Theobald Smith and Dr. Carlon TenBroeck.

Tropical Medicine. Professor R. P. Strong.

Group II. Personal Hygiene

Personal Hygiene. Professor W. B. Cannon.

Personal Hygiene. Professor P. G. Stiles.

Industrial Hygiene and Sanitation. Professor S. M. Gunn.

Group III. Public Health Administration

Practical Health Administration. Dr. M. W. Richardson, Dr. W. C. Hanson and Mr. H. C. Lythgoe.

Sanitary Law. Professors W. T. Sedgwick, S. C. Prescott, R. S. Weston and S. M. Gunn.

Municipal Sanitation. Professor S. M. Gunn, Mr. R. N. Hoyt.

Sanitation of Houses and Public Buildings. Professor S. M. Gunn.

Public Health Administration. Professor S. M. Gunn and Mr. R. N. Hoyt.

Hygiene of Ventilation and Heating. Professor W. T. Sedgwick.

Group IV. Sanitary Biology and Sanitary Chemistry

Protozoology. Professors Theobald Smith and E. E. Tyzzer.

Entomology. Professor W. M. Wheeler and Asst. Professor C. T. Brues.

Advanced Bacteriology. Dr. E. C. Howe.

Bacteriology of Tropical Diseases. Professors H. C. Ernst and S. B. Wolbach and Dr. Austin.

Dairy Bacteriology. Professor S. C. Prescott.

Bacteriology of Water and Sewage. Professor S. C. Prescott.

Zoology and Parasitology. Professor R. P. Bigelow.

Helminthology. Dr. Philip E. Garrison.

Sanitary Biology. Dr. J. W. M. Bunker.

Analysis of Water, Sewage and Air. Dr. J. W. M. Bunker.

Water and Air Analysis. Dr. J. F. Norton.

Water Supplies and Waste Disposal. Dr. J. F. Norton.

Food Analysis. Professor A. G. Woodman.

Advanced Food Analysis. Professor A. G. Woodman.

Group V. Special Pathology

Comparative Pathology of Tropical Diseases. Professor Theobald Smith.

Pathology of Tropical Diseases. Professor F. B. Mallory.

Clinical Laboratory Work. Professors H. C. Ernst and S. B. Wolbach and Dr. Austin.

Group VI. Communicable Diseases

Communicable Diseases. Dr. E. H. Place.

Communicable Diseases (Interneship at South Department, Boston City Hospital). Dr. E. H. Place.

Biology of Infectious Diseases. Professor S. M. Gunn.

Board of Health Diagnosis. Dr. F. H. Slack.

Public Health Laboratory Methods. Professor S. M. Gunn and Associates.

The Diagnosis of Rabies and Glanders by Laboratory Methods. Dr. Langdon Frothingham and Dr. E. F. Walsh.

Group VII. Sanitary Engineering

Sanitary Engineering. Professor G. C. Whipple and Assistants.
Sanitary Engineering—Summer Course. Professor G. C. Whipple and Assistants.
Water Supply Engineering. Professor G. C. Whipple.
Sewerage Engineering. Professor G. C. Whipple.
Limnology. Professor G. C. Whipple, Dr. J. W. M. Bunker and Assistants.
Sanitary Research Laboratory. Mr. M. C. Whipple.
Rural Sanitation. Dr. J. W. M. Bunker.
Hydraulic and Sanitary Engineering. Professor Dwight Porter.
Advanced Hydraulic and Sanitary Engineering. Professor Dwight Porter.
Engineering of Water and Sewage Purification. Professor Dwight Porter.
Theory and Practise of Water and Sewage Purification. Professor R. S. Weston.

Group VIII. Demography

Demography. Professor G. C. Whipple and Assistants.
Sanitary Biometrics. Professor S. M. Gunn.
Vital and Sanitary Statistics. Professor D. R. Dewey.

SPECIAL COURSES AND LECTURES

Group I. Preventive Medicine

Infant Mortality. Professor J. L. Morse.
Genetics and Eugenics. Professor W. E. Castle.
Social Service Work. Professor R. C. Cabot and Miss Ida Cannon.
Tropical Dermatology. Professor R. P. Strong and Dr. H. P. Towle.

Group II. Personal Hygiene

School Hygiene. Dr. T. F. Harrington.
Mental Hygiene. Professor E. E. Southard and Associates.
Venereal Prophylaxis. Professor E. H. Nichols.
Tropical Sunlight. Professor Theodore Lyman.
Posture and Deformities. Professor R. W. Lovett.
Ocular Hygiene. Dr. F. H. Verhoeff.
Oral Prophylaxis. Professor W. H. Potter.
Prevention of Diseases of the Ear. Dr. H. P. Mosher.

Group III. Public Health Administration

Sanitary Law—Legal Powers of Health Officers. Professor Eugene Wambaugh.
Medical Inspection of Immigrants. Dr. M. V. Safford.
Municipal Sanitation. Dr. C. V. Chapin.

Group IV. Sanitary Biology and Sanitary Chemistry

Venomous Animals. Dr. Thomas Barbour.
Poisonous Plants of the Tropics. Professor W. J. V. Osterhout.

Climatology. Professor R. DeC. Ward.

Group VI. Communicable Diseases

Tuberculosis. Dr. J. B. Hawes, 2d.

Group IX. Medical and Other Sciences

The following courses are also open to students registered in the School for Health Officers:

At Harvard Medical School:
- Anatomy, gross and microscopical.
- Embryology.
- Physiology.
- Biological Chemistry.
- Pathology.
- Bacteriology.

At the Massachusetts Institute of Technology:
- General Bacteriology. Professor S. G. Prescott.
- General Physiology. Professor P. G. Stiles.
- Physiological Laboratory. Dr. E. C. Howe.
- Vertebrate Anatomy. Professor R. P. Bigelow.

At Harvard University:
- Elementary Bacteriology. Dr. J. W. M. Bunker.

This intellectual bill of fare is not as complicated as it looks, but the long list of courses shows the opportunities offered by the educational institutions in Boston for students of public health. In fact, the resources of one of the oldest and best medical schools and the first great engineering school of the country are available, and to these should be added the opportunities presented for cooperation with the Massachusetts State Board of Health, the Board of Health of the City of Boston, the various hospitals in the city, and the excellent medical and engineering libraries.

It is not the food which is put upon the table, but that which is eaten and digested, which nourishes. It is not what the student has opportunity to learn, but what he does

learn that counts. And perhaps the best thing to be said about the new School for Health Officers is that it is a combination of schools which have been noted for efficient instruction and for the hard work done by the students. The Harvard motto "Veritas" is combined with the Institute motto "Mens et manus"—mind and hand working together for the truth, or truth expressing itself through mind and hand. We believe that the spirit which has created these two institutions will not fail to build up a school of public health which will faithfully serve its day and generation.

But lest I be accused of screwing the nut too tightly upon Boston as the hub of the universe let me say that we who shelter ourselves beneath the fins of the codfish do not claim to have a monopoly of the sea. What has most impressed us in making our plans has been not the magnificence of our Boston institutions, but the magnitude of the problem which the country has to solve—the problem of ministering to the health of a hundred million people gathered from all the quarters of the globe.

In conclusion, let me restate the ideal for which the School for Health Officers of Harvard University and the Massachusetts Institute of Technology stands—for a body of educated sanitarians working in many fields and well-trained for their particular work—but especially for the health officer whose education is based on all four of the great professions—medicine, engineering, law and social service. And it calls to the states and cities and towns of the country and says, "This is the kind of a man you need to protect your public health, a man broadly trained and well-paid who can afford to give all his time and all of the best that is in him to the work." It calls to the legislators and says, "Amend your laws so that you can get this kind of men." It calls to the young men of the country and says, "The field is ripe for the harvest." And it calls to the other universities and says, "Join us in this great movement to secure men for the public health service." Let us all work together for the health of the country and the health of the world.

George C. Whipple
Harvard University

Scientific Notes and News

Among the thirty-seven honorary degrees conferred on the occasion of the one hundred and fiftieth anniversary of the founding of Brown University were two doctorates of science, given to Dr. Simon Flexner, director of the laboratories of the Rockefeller Institute for Medical Research, and Dr. L. A. Bauer, director of the department of terrestrial magnetism of the Carnegie Institution.

At the celebration of the twenty-fifth anniversary of the Johns Hopkins Hospital a portrait of Sir William Osler, by Mr. Sargeant, was presented.

Mr. Douglas W. Freshfield, known for his publications on mountains and other subjects, has been elected president of the Royal Geographical Society.

Professors Roentgen, Lenard and Behring have each recently been reported to have repudiated the gold medals conferred on them by scientific associations in Great Britain, and have donated them to the Red Cross or other relief work, and now it is said that the Hanbury medal has likewise been donated for relief work by its recipient, Dr. E. Schmidt, professor of pharmacology at Marburg.

Dr. George H. Whipple, a graduate in 1900 of Yale and M.D. in 1905 of Johns Hopkins, and since 1906 a member of the faculty of the department of pathology of Johns Hopkins Medical School, has taken up his new duties as director of the George Williams Hooper Foundation for Medical Research, to endow which Mrs. Sophronia T. Hooper of San Francisco recently gave to the University of California property valued at much more than a million dollars. Three other appointments have been made to the foundation. Dr. Karl Friedrich Meyer and Dr. Ernest Linwood are to become associate professors of tropical medicine, and Dr. Charles W. Hooper is to be fellow in research medicine. The head-

quarters of the foundation will be in special laboratories at the University of California Medical School buildings on Parnassus Avenue, San Francisco.

DR. BENJAMIN WHITE, formerly director of the department of bacteriology of the Hoagland Laboratory, Brooklyn, is now assistant director of bacteriological laboratories of the department of health, New York City, and is in charge of the research and antitoxin laboratories at Otisville, and Dr. Harold Lyall, formerly associate director of the department of bacteriology of the Hoagland Laboratory, is now bacteriologist at the Otisville laboratories.

DR. S. MORGULIS has been placed in charge of an investigation of the metabolism of fish by the Bureau of Fisheries of Washington, D. C. The investigation is being conducted in the New York Aquarium and in the biochemical laboratory of the College of Physicians and Surgeons, Columbia University.

DR. W. J. DILLING, of Aberdeen, has been appointed to the newly established "Robert Pollok" lectureship, for research in materia medica and pharmacology, at the University of Glasgow.

PROFESSOR ALBERT PERRY BRIGHAM has returned to Colgate University after spending the past year in Europe. In August he gave a course of seven lectures before the Oxford University school of geography, on "Regional development and conservation problems in the United States."

MR. LEO E. MILLER, of the Roosevelt expedition to South America, has completed plans for another expedition. He will leave New York within a few days for Porto Columbia, where he will begin his trip of exploration in the interest of the American Museum of Natural History. The expedition is supported by a gift of $5,000 from Mr. Roosevelt.

NEWS has been received from Professor William M. Davis, formerly head of the Harvard geological department, who after the meeting of the British Association visited in late August and early September the Great Barrier reefs of the Queensland coast of northeastern Australia, and on September 11 sailed from Sydney via New Zealand to the Society Islands, where he expected to spend a month examining Tahiti and other members of that group. He expects to return to Cambridge early in November.

PRESIDENT HARRY PRATT JUDSON, who has been absent for six months from the University of Chicago in the prosecution of his duties as chairman of the China Medical Commission of the Rockefeller Foundation, sailed from Yokohama, Japan, September 29 on the Pacific Mail Steamship *Mongolia*.

PROFESSOR HORATIO H. NEWMAN, of the department of zoology in the University of Chicago, will give before the College Endowment Association of Milwaukee, Wisconsin, a series of four lectures on the general subject of "The Social Life of Animal Communities." He will discuss in the opening lecture parental care, mutual aid, and social life among animals. In the second lecture will be considered community life among bees and wasps, and recent discoveries concerning their habits and intelligence. In the third lecture he will discuss ant communities, their agriculture, armies, battles, and slavery; and in the last, the most complex insect communities—termites or white ants.

MISS ELLEN B. SCRIPPS has made a gift of $35,000 (in addition to $60,000 previously subscribed by herself) for a pier, pumping plant and additional equipment for the Scripps Institution for Biological Research, at La Jolla, near San Diego, California. For its maintenance she gives yearly to the University of California $10,000.

THE annual meeting of the Association of American Universities will be held at Princeton on November 6 and 7.

THE annual meeting of the Society of American Bacteriologists will be held in Philadelphia, December 29, 30 and 31, 1914, under the presidency of Professor Charles E. Marshall. The session programs will be arranged as follows:

Tuesday, A.M. Systematic Bacteriology, H. A. Harding, Urbana, Ill.

Tuesday, P.M. Technique, G. F. Ruediger, La Salle, Ill.

Wednesday, A.M. Industrial Bacteriology, R. E. Buchanan, Ames, Iowa.
Wednesday, P.M. Sanitary Bacteriology.
Thursday, A.M. Infection and Immunity, J. A. Kolmer, Medical Dep't University of Pennsylvania, Philadelphia, Pa.
Thursday, P.M. Ventilation, C.-E. A. Winslow, 25 West 45th Street, New York City, N. Y.

On Thursday afternoon the session will be devoted to a symposium on Ventilation with Section K of the American Association for the Advancement of Science. Professor C.-E. A. Winslow has this program in charge. The local committee of arrangements consists of D. H. Bergey, Jos. Leidy, Jr., Jos. McFarland and A. Parker Hitchens, chairman. The secretary is A. Parker Hitchens, Glenolden, Pa.

The eminent French physicist, Professor Ch. Fabry, of the Faculté des Sciences, Marseilles, is devoting himself to radiography for the benefit of the wounded in the war. He fears an exhaustion of the French supply of X-ray tubes and has written to an American friend, requesting that makers and dealers in such supplies should communicate with him at once, giving prices of their supplies and tubes for medical and surgical purposes.

"Mendel's Vererbungstheorien aus dem Englischen übersetzt von alma Winckler mit einem Begleitwort von R von Wettstein." Teubner, Leipzig, 1914, is a German edition of Dr. W. Bateson's well-known book recently reviewed in these columns. It will be useful to those who read German more readily than English, or by preference.

Dr. Henry Chandler Cowles, associate professor of plant ecology in the University of Chicago, was engaged some time ago by the United States Department of Justice to make an investigation of a large tract of timber land in Arkansas which had been originally surveyed as lake. Professor Cowles's services as an ecological expert were secured to determine from the nature of the timber and other evidence whether or not the area could possibly have been lake as recently as the time of the original survey in 1847. The investigation was made and testimony given, and the United States judge of that district gave a sweeping decision in favor of the government's contention. Among the findings was that none of the areas returned as lake had any evidence of a beach line such as should have existed. But the most striking evidence of the fraudulency of the original survey was the existence of immense upland trees growing over all the areas, many of the trees being from two hundred to three hundred years old, and some of them from five hundred to a thousand.

"The Production of Explosives in the United States during the Calendar Year 1913" has just been published by the United States Bureau of Mines. The total production of explosives, according to the figures received from manufacturers, was 463,514,881 pounds (231,757 short tons), as compared with 489,393,131 pounds (244,696 short tons), for 1912. This production is segregated as follows: black powder, 194,146,747 pounds; "high" explosives other than permissible explosives, 241,682,364 pounds, and permissible explosives, 27,685,770 pounds. These figures represent a decrease of 36,146,622 pounds of black powder and an increase of 7,212,872 pounds of high explosives and 3,055,500 pounds of permissible explosives. As explosives are essential to mining, and the use of improved types of explosives lessens the dangers of mining, the Bureau of Mines undertook the compilation of information showing the total amount of explosives manufactured and used in the United States, its first report dealing with the year 1912. This is the second technical paper relating solely to the production of explosives that the bureau has issued. It is expected that similar publications will be compiled annually, and that with the cooperation of the manufacturers these statements will be published within a few weeks after the end of each year. The figures show that in 1902 only 11,300 pounds of permissible explosives was used in coal mining, whereas in 1913 the quantity so used was 21,804,285 pounds. The quantity of permissible explosives used in the United States is larger than in a number of foreign countries. In 1912 it represented about five per cent. of the total quantity of explosives produced, and in 1913 six per cent. The total

amount of explosives used for the production of coal in 1913 was 209,352,938 pounds, of which about ten per cent. was of the permissible class as compared with eight per cent. in 1912. The use of permissible explosives in coal mining has had gratifying results, and few, if any, serious accidents can be attributed directly to their use.

THE consumption of white arsenic in the United States in 1913 amounted to about 7,200 tons, valued at $570,000, of which 2,513 tons, valued at $159,236, was produced in this country as a by-product from copper and precious-metal smelters, and the remainder was imported largely from European countries. For the present imports of arsenic will probably be seriously diminished and the American smelters can save much more arsenic than they do now, for the cheapness of the product has prevented the saving of all that was practicable. Works for the exclusive production of arsenic have been erected at only two places in the United States—Brinton, Va., and Mineral, Wash. It is difficult for such plants to produce arsenic to be sold in competition with the by-product of the smelters except in periods of high prices, such as may again prevail if the industrial disturbances are long continued.

THE value of the mineral production of the United States now exceeds $2,500,000,000 a year, according to the United States Geological Survey. Though this value falls far below that of the country's farm products, the magnitude and scope of our mineral industry may be best measured by comparing our own mineral production with that of other countries, no one of which can compete with us in abundance or variety of mineral resources. The United States mines nearly 40 per cent. of the world's output of coal and produced 65 per cent. of the petroleum in 1913. Of the more essential metals, 40 per cent. of the world's output of iron ore is raised from American mines, and the smelters of the United States furnish the world with 55 per cent. of its copper and at least 30 per cent. of its lead and zinc. These are the raw materials on which has been founded a great metallurgical industry, but on which can be built much more extensive chemical and metal-working industries.

ACCORDING to statistics recently completed by Ernest F. Burchard, of the United States Geological Survey, the production and shipments of iron ore in the United States exceeded those of any previous year. The crude iron ore mined in the United States in 1913 amounted to 61,980,437 long tons, compared with 55,150,147 tons mined in 1912—an increase of 6,830,290 tons, or 12.38 per cent. The iron ore shipped from the mines in the United States in 1913 amounted to 59,643,098 long tons, valued at $130,905,558, compared with 57,017,614 long tons, valued at $107,050,153, marketed in 1912—an increase in quantity of 2,2625,484 long tons, or 4.60 per cent., and in value of $23,855,405 or 22.28 per cent. The average price of ore per ton for the whole country in 1913 was $2.19, compared with $1.88 in 1912. These quantities of ore, both mined and marketed, include the iron ore used for fluxing other metallic ores at smelters in the Middle and Western states, but do not include the iron ore sold for the manufacture of paint. The iron ore marketed for paint in 1913 amounted to 16,950 long tons, valued at $44,851. The ore reported as sold for fluxing purposes other than in the manufacture of pig iron amounted to 62,842 long tons, valued at $235,588, in 1913, compared with 88,449 long tons, valued at $244,315, in 1912. The domestic iron ore actually marketed for the manufacture of pig iron amounted in 1913 to 59,580,256 long tons, valued at $130,669,970, compared with 56,929,165 long tons, valued at $106,805,838, in 1912. Iron ore was mined in 28 states in 1913, one more than in 1912. Idaho, Montana and Nevada produced ores for fluxing only; part of Colorado's output was used for fluxing and part for pig iron; a little magnetic ore mined in Utah was shipped to a Salt Lake iron foundry for testing a new method of reduction, and the remainder of the Utah ore was used for fluxing. The other states produced iron ore for blast-furnace use only, except small quantities for paint from Georgia, Michigan, New York and Wis-

consin, which are, however, excluded from the above figures for iron ore. The rank of the five states producing the largest quantity of iron ore—Minnesota, Michigan, Alabama, New York and Wisconsin—remained unchanged in 1913, but there were a few changes in the relative rank of certain of the smaller producers. The Minnesota iron ranges are yielding at present considerably more iron ore than is produced in all the rest of the states together, having furnished 62.37 per cent. of the total for the United States in 1913. The Lake Superior district, comprising all the mines in Minnesota and Michigan and those in northern Wisconsin, mined 52,377,362 tons in 1913, or 84.51 per cent. of the total.

UNIVERSITY AND EDUCATIONAL NEWS

Phillips Academy, Andover, Mass., receives a bequest of about $462,000 under the will of Melville C. Day, of New York, who died in Florence, Italy. This amount is the residue of the estate. At the termination of a life estate created for the benefit of a friend, Phillips Andover will receive a further sum of about $45,000.

Frederick William Dohrmann, for a number of years a regent of the University of California, has bequeathed $5,000 as a loan fund, for loans to members of the faculty to tide them over hard places in times of illness or other emergency.

Brown University celebrated last week the one hundred and fiftieth anniversary of its foundation. Among the events were historical addresses by Dr. W. W. Keen, of Philadelphia, and the Hon. Charles E. Hughes, of the Supreme Court. Dr. William Peterson, principal of McGill University, gave the university address. Thirty-seven honorary degrees were conferred, the recipients including the presidents of the seven universities established before Brown. There were many academic exercises and entertainments.

The University of Louvain has accepted the offer of the Cambridge University to give the use of its libraries, laboratories and lecture rooms during the present crisis, without the payment of the usual fees, in order that the work of the Belgian University as a corporate body may be carried on without breach of continuity. Cambridge University has only 1,500 students, as against 3,500 last year, and other institutions have lost students in about the same proportion. The German universities expect about one third the usual attendance.

The last year of the post-graduate course of the Naval Academy at Annapolis is now taken at the school of engineering at Columbia University and seventeen lieutenants and one ensign, in active service in the U. S. Navy, are in attendance. Under the naval regulations the course is of two years, and both were taken at Annapolis until last year. It was decided, however, that, while the instruction at the academy was feasible as far as the first year was concerned, the equipment then was not sufficient for the second year, so Columbia was chosen for the more advanced work.

The attendance at the University of Chicago for the summer quarter has been announced, and shows an advance over the registration for the corresponding quarter a year ago. The total number of men registered in the graduate schools of arts, literature and science was 860 and of women, 528, a total of 1,388; in the senior and junior colleges 572 men and 605 women, a total of 1,177; in the professional schools, divinity 282, medicine 135, law 163, education 991, making a total of 1,571; and excluding duplications, the registration for the entire university was 3,974, the largest summer registration in the history of the institution.

Cornell University Medical College opened with an enrollment as follows: For the degree of M.D., first year, 55; second year, 28; third year, 32; fourth year, 20: special students (work not leading to the degree of M.D.), 12: for the degree Ph.D., 5, making a total of 152. All students now registered, with the exception of those pursuing the combined seven years' course leading to the degrees of A.B. and M.D., are graduates of arts and sciences, or doctors

of medicine doing advanced work. Students in the combined course present the baccalaureate degree before they are admitted to the second year in medicine.

IN accordance with the agreements for cooperation between the Massachusetts Institute of Technology and Harvard University, fifteen of the Harvard professors are to be added to the instructing staff of the institute this year. Their names and departments are the following:—*Mining Department:* Professors Henry Lloyd Smyth, Edward Dyer Peters, Albert Sauveur, George Sharpe Raymer, Charles Henry White and Louis Caryl Graton. *Mechanical Engineering Department:* Professors Lionel Simeon Marks and Arthur Edwin Norton. *Drawing, Civil Engineering Department:* Professors George Fillmore Swain, Lewis Jerome Johnson, Hector James Hughes and George Chandler Whipple. *Department of Electrical Engineering:* Professors Arthur Edwin Kennelly, Harry Ellsworth Clifford and Comfort Avery Adams.

AT the University of Pennsylvania promotions include the following: Dr. Bradley Moore Davis, to be professor of botany; Dr. Oliver Edmunds Glen, to be professor of mathematics; Dr. Howard Hawks Mitchell, to be assistant professor of mathematics; Dr. Melvin Reece Harkins and Dr. Dicran Hadjy Kabakjian, to be assistant professors of physics; Dr. Samuel G. Barton, to be assistant professor of astronomy. Dr. Lowell J. Reed has been appointed instructor in mathematics, and Mr. E. J. Lund instructor in zoology.

AT Rutgers College Professor Alfred A. Titsworth has been appointed dean of mechanical arts and Professor Jacob C. Lipman, dean of agriculture.

DR. ALEXANDER J. INGLIS has resigned as professor of the science of teaching at Rutgers College, to become assistant professor of education in Harvard University.

GEORGE H. CHADWICK, for seven years professor of geology at St. Lawrence University, is now connected with the department of geology at the University of Rochester. His successor at St. Lawrence is Dr. C. J. Sarle.

DR. CHARLES OSCAR CHAMBERS has been appointed instructor in agriculture, biology and applied chemistry at the George Peabody College for Teachers. He comes from the University of Cincinnati, where he was acting head of the department of biology last year.

DR. PAUL B. CLARK, of the Rockefeller Institute for Medical Research, has been appointed associate professor of bacteriology in the University of Wisconsin, succeeding Dr. Mazyck P. Ravenel, who has gone to the University of Missouri.

DISCUSSION AND CORRESPONDENCE

HEREDITY AND ENVIRONMENT

TO THE EDITOR OF SCIENCE: Some discussion has been held lately in the columns of SCIENCE concerning the question of the influence of monarchs and the relations of heredity to the manifestations of statecraft and warcraft in rulers. Professor Woods has been one of the champions of the view that monarchs and their immediate kin show exceptional excellence in both these lines, and he has based his thesis on a wealth of illustration from history, that, apart from his interpretation, must command admiration as a scientific inquiry.

One point will, I think, be admitted by all who go somewhat deeply into the problem of descent, and, that is, that starting with beings of good physical and mental characteristics, inbreeding will emphasize many of these and produce a well marked and strong race. The Jews and the Irish show this fact. Both have been to a large extent close bred, due partly to religious, partly to geographic conditions. For centuries the Jew was separated from the other races by his adhering to a peculiarly exclusive religious code. The Irish—I refer, of course to the Roman Catholic Irish—were for centuries separated by island habitation, as well as intense religious antagonisms, from their nearest neighbors. Even in the melting pot—the United States—the two strains have been kept well apart from each other and from the bulk of the population. Intermarriage between Jews and Christians, or between Irish Catholics and Protestants, or even

between Irish and German Catholics are only occasional.

When, however, we come to ascertain the relative value of heredity and environment in determining the character of offspring, it seems to me that it is necessary to use extreme caution, to eliminate, on the one hand, mere coincidence, and on the other hand to avoid confusing the two influences. The development of the germ cell and the fertilizing cell we must consider heredity, but gestation is largely environment, and surely this period is of profound importance to the new being, especially in the case of human beings, with which the period is long and markedly subject to psychic influences. The period of infancy is, so far as rulers, or the highest social classes even, are concerned, a period of special environment, eminently adapted to continue and intensify any qualities distinctly marked in the parents. Monarchs' children are from their birth set apart from the world at large, surrounded by an atmosphere of authority and pretense; surely these conditions must have a large share in determining character. If one feature looms largest in the characters of rulers throughout the ages, it is their ruthlessness, that is, their indifference to the rights and feelings of their subjects. Just as the mass of children learn from their parents and associates to consider the lower animals as having no rights that human beings are bound to respect, so the young prince is taught to regard the mass of his nation.

Nor can we overlook opportunity as an element in favoring the ruler. By the very condition of things, his views prevail. In the light of modern theories, especially, the materialistic conception of history, are not many of the incidents of a given reign merely manifestations of causes within the core of humanity itself, and the monarch a creature of such causes rather than himself a cause? In other words, in ascribing to Louis XIV. a profound share of the development of France, are we not making the mistake of assigning Tenterden steeple as the cause of Goodwin Sands? "There was a man sent from God whose name was John." Is it permissible to say that there was a man sent from God whose name was Abraham Lincoln? Can any one assert that Abraham Lincoln was any more necessary to the working out of a proper destiny of this country than a hundred of the prominent statesmen, north and south, in his day? I think it has been proved by Adams in his recently published volume, that the success of the Federal forces was almost entirely due to the efficiency of the blockade of the ports of the Confederacy.

In Professor Woods's two volumes on this topic we miss a study of the influence of two important classes of rulers with whom heredity can have little concern, namely, the popes and the presidents of the United States. Chosen under more or less emotional conditions, a long line of pontiffs exhibits striking examples of human excellence and human failings. The latest, and probably the best authority, on this series—the Catholic Encyclopædia—places Gregory VII. as the greatest of them, yet by his own statement he was from the proletarian. Of recent popes, Leo XIII. is the most able; his claim for noble descent was only established with difficulty and there is no ascription to him of blood royal.

Then what is to be said of the great line of American statesmen, drawn from the lower ranks, such as Franklin, Paine, Hamilton, Jackson, Lincoln? It is admitted that the cause of American independence was furthered as much by a journeyman printer and a journeyman corset maker, as by any one.

Henry Leffmann

A FEMINIZED COCKEREL

From time to time during the last five years, grafts of various sorts have been attempted in connection with studies of the effects of castration on the domestic fowl. The condition of one of the birds on which grafts have been made is of particular interest.

A Brown Leghorn *male* was castrated completely when 24 days of age and the ovaries from two brood sisters, cut in several pieces, were placed beneath the skin and also within the abdominal cavity.

At date of writing, the bird is as obviously

a female in general appearance as its brood sisters. Several skilled poultrymen, when shown the bird, have unhesitatingly pronounced it a pullet.

Aside from a perfectly clear record, the marks of the operation, which are still visible, show that the bird when operated on must have been a male.

While possible that this particular individual may owe its feminized character to a constitutional condition, such as hen feathering, such an assumption is extremely improbable. Rather, it seems more probable that the bird has actually been feminized by the implanted ovaries in similar fashion to the rats and guinea-pigs of Steinach.

A full account of the bird will be published after it has been under observation for several months.

H. D. GOODALE
MASSACHUSETTS EXPERIMENT STATION,
AMHERST, MASS.

A THIRD ORDER RAINBOW

TO THE EDITOR OF SCIENCE: On September 11, as I stood near the lake in Beardsley Park, Bridgeport, Conn., I observed a rainbow in such an unusual position that it seems to be worthy of some short description. The rainbow was first noticed about a quarter of five in the afternoon, with the sun perhaps 60° from the zenith. The sky in general was clear, though there were heavy clouds above the eastern horizon and very light cloud streaks between the observer and the sun, with a few fleecy clouds near the zenith. No rain was falling, and probably none had fallen in the region for some time, nor was there indication that any would fall for hours; yet, between the observer and the sun, some 10° from the zenith, there appeared between two of the clouds a distinct rainbow, clearly observed by others whose attention was called to the phenomenon.

The bow was rather short, not over an eighth of a circumference, convex toward the sun, and showed plainly the usual rainbow colors. Not until the bow had faded to such an extent that the colors were no longer marked was it recalled that no accurate statement of the order of colors could be given. It is my impression now that the red was on the convex side.

Wood's "Physical Optics," second edition, p. 343, gives for the deviation produced by K internal reflections in a sphere

$$D = 2(i - r) + k(\pi - 2r)$$

and for minimum deviation,

$$\cos i = \sqrt{\frac{\mu^2 - 1}{K^2 + 2K}}.$$

For $K = 3$, this gives

$$i = 76° 50,$$
$$r = 46° 55',$$
$$D = 318° 20',$$

whence the angle between the emergent and incident light would be about 42°. This would agree fairly well with the rough estimate of 50°. Hence the conclusion that the rainbow observed was the result of three internal reflections within suspended drops of such small size and number as to give no appearance of a cloud.

Various authorities, however, state with more or less emphasis that the bows corresponding to three reflections are never seen on account of the much more intense direct light from the sun. In the case cited above it would seem that the light clouds directly between the observer and the sun served to diminish the intensity of the direct light to such an extent that the bow was plainly seen.

This seems to be the only explanation for the bow, but considering the very light clouds noted above, the observation is all the more remarkable.

H. W. FARWELL

A SOLAR HALO IN VIRGINIA

THE solar halo, a sketch of which is appended, was visible over a considerable portion of east Virginia for several hours on Sunday, November 2, 1913. It was observed by the writer at Fredericksburg, Virginia, at one P.M. on that day. The phenomenon was of the greatest brilliancy, the acessory "suns" being at times almost as brilliant as the sun itself. The great circles around the horizon were dis-

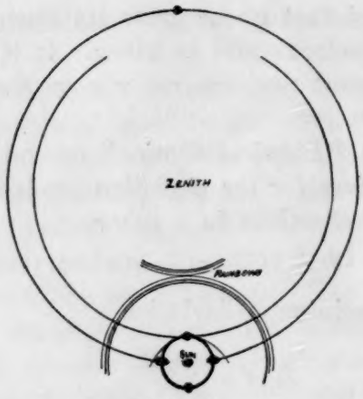

FIG. 1.

tinctly marked, and persisted for hours. The bright spot at the opposite pole from the sun was only occasionally visible. The rainbows were brilliantly colored and could be seen until the sun was almost down.

The sky at the time was almost clear, except for a few wisps of cloud and a thin haze which was densest directly over the face of the sun.

A. W. FREEMAN

SCIENTIFIC BOOKS

Photo-electricity. By H. STANLEY ALLEN. London, Longmans, Green and Co., 1913. 8vo. Pp. ix + 221. Price $2.10 net.

Photo-electricity. By ARTHUR LLEWELYN HUGHES. Cambridge, The University Press, 1914. 8vo. Pp. viii + 144.

The present generation of physicists has seen the rapid and almost spectacular development of several important fields of activity in physics: such, for example, as the subject of electric waves, of kathode rays and electrons, of X-rays, and of radioactivity. While the subject of photo-electricity has not aroused the same widespread and popular interest as the subjects just mentioned, there are at present many reasons for believing that the study of photo-electric phenomena may prove to be of almost equal importance in its bearing upon theories of atomic structure and of radiation.

I imagine that most physicists have read the paper in which Hertz described his discovery of the photo-electric effect. The paper is reprinted in Hertz's "Ausbreitung der elektrischen Kraft" and in the English translation "Electric Waves." I can think of no scientific article which illustrates so well not only what research in experimental physics ought to be, but also how the results should be presented. It is a good illustration also of the importance of the unexpected things that so frequently turn up in experimental work. It will be remembered that the discovery of the photo-electric effect came as an incident in Hertz's work on electric waves. As difficulty was experienced in seeing the minute sparks that indicated the response of the resonator, he tried to improve matters by placing a box around the gap so as to screen the eyes. But instead of making it easier to see the sparks the box apparently made the resonator less sensitive. I imagine that most of us would have been content to call the attempted improvement a failure, and would have dismissed the matter with mingled feelings of mild wonder that the scheme didn't work, and regret that we had wasted so much time in making the box. But Hertz was not content to simply wonder. He set out to discover why the box had such an unexpected effect, and by a beautifully logical series of experiments and deductions he found the answer to his question. Since it appeared that the new phenomenon had no bearing upon what he regarded as his more important problem, he left its further study to others and returned to the subject of electric waves.

Hertz's paper aroused wide-spread interest and the work was quickly taken up by others. During the first nine years after Hertz's discovery more than one hundred articles dealing with the photo-electric effect were published, and interest in the subject has continued undiminished since. As no résumé of the subject has been published which is at all complete, it is clear that the physicist who wishes to make himself familiar with what has been done in this important field has no small task before him.[1] The almost simultaneous

[1] A résumé of work on the photo-electric effect was published in SCIENCE, Vol. IV., p. 853 and p. 890, 1896, which was, I believe, complete to the time of publication. The subject has developed so greatly since that time, however, that this summary has little more than historical interest.

appearance of two books on the subject of photo-electricity is a welcome response to a very general demand.

Dr. Allen's book is intermediate in character between a popular or semipopular presentation—such as would be suitable for the reader with a general scientific interest, or for workers in subjects related to physics—and a detailed summary intended for the specialist. After two introductory chapters, giving a very brief general survey of the whole field and an account of the work of the early experimenters, the author takes up in greater detail such subjects as the emission of electrons in a vacuum, the velocity of the electrons emitted, the photo-electric behavior of different substances, the influence on photo-electric phenomena of gas-pressure, temperature and the wave-length of the exciting light, and photo-electric fatigue, to whose experimental study Dr. Allen has himself contributed. Then follow chapters on "Theories of Photo-electric Action," "Fluorescence and Phosphorescence," and "Photo-electrical Actions and Photography." Since the topics treated in the last two chapters, although probably related to the subject of photo-electricity, are not to be regarded as essential parts of the general subject, the author makes no attempt at a complete treatment of these topics.

Dr. Allen makes no attempt to summarize all the articles dealing with photo-electricity, and has not given a complete bibliography. The value of the book would have been greatly increased if a complete list of articles had been given. But even without this the book is of great value. In discussing each topic references are given to some of the more important original articles, so that the reader who wishes to go into the subject in detail will be greatly helped.

For the specialist I imagine that Dr. Hughes's book will be found the more useful of the two. It assumes considerable familiarity on the part of the reader with the subject and with related subjects, and goes into greater detail in the critical discussion of the results obtained by different observers. This is especially true in the case of those phases of the subject which are now attracting most attention. At the end of each chapter there is a summary of results, and in many cases a discussion of their theoretical bearing, which will be found very useful. References to original sources, although not complete, include most of the more important articles. In the main the ground covered is the same for the two books. Dr. Hughes includes, however, a chapter on the ionization of gases by ultra-violet light, which is looked upon as one instance of photo-electric action. There are also short chapters on positive rays produced by light, and on the sources of light used in photo-electric experiments. On the other hand the treatment of photo-electric fatigue is less complete than in Dr. Allen's book, and the subjects of luminescence and of photographic action, to which Dr. Allen devotes two chapters, are not taken up at all.

In discussing the velocity of emission of photo-electrons Dr. Hughes points out that while it seems probable that a linear relation exists between the maximum energy of the photo-electrons and the frequency of the exciting light, so that the retarding potential necessary to prevent discharge is given by $V = kn - V_0$, the constant k has not been found to have the value h/e which Einstein's theory, based on the theory of quanta, would lead us to expect. Since this chapter was written Millikan's measurements on sodium have not only established the linear relation between V and n with greater exactness and through a wider range than has been done by any previous investigation but have also led to a value of ke which differs from h by considerably less than the uncertainties in the value of Planck's constant. This chapter of Hughes's book would undoubtedly have been considerably modified if it had been written after the publication of Millikan's work. Nevertheless the author's discussion retains its value, for the results obtained by other observers still requires explanation.

I am convinced that these books will be found most useful, both by those who wish only to be informed regarding recent progress in the subject of photo-electricity and by those who are engaged in investigation in this field.

ERNEST MERRITT

PEARSON'S TABLES FOR STATISTICIANS AND BIOMETRICIANS

When one is told that the advance of science is in a high degree dependent upon improvements in technique, one naturally thinks of the astronomical and physical instruments of precision, the calorimeters of the chemist's equipment, the microtomes and microscopes of the general biological laboratory, and of the pure culture and surgical technique of the clinic. With such magnificent examples of instrumental facilities for research, it is easy to forget the large debt of modern science to mathematical methods of description and analysis. Even if one limits oneself to the cases in which the mathematical tools have taken the most workable form—that of tables of final constants for given value of observation or tables to facilitate the calculation of such constants—the debt is enormous. Who can estimate the service to applied science of the engineer's pocket books of formulæ and tables? or the value to pure science of the convenient volumes of logs and trigonometric functions? or, to be both specific and modern, of such volumes as the "Physikalish-chemische Tabellen" of Landolt and Börnstein, the tables for physicists and chemists of Castell-Evans, and the "Annual Tables of Constants and Numerical Data" published by the Commission of the International Congresses of Applied Chemistry?

The most recent advance of this kind is marked by the publication of a series of tables for the use of statisticians and biometricians.

With the foundation of the Biometric School of Biology, there were available only the general aids to calculation—tables of logarithms and trigonometric functions, Barlow's tables[1] and Crelle's.[2]

All of these are still to some extent useful, though the improvement of calculating machines has rendered them less indispensable.

[1] Barlow's tables of squares, cubes, square roots, cube roots and reciprocals of all numbers up to 10,000. London, Spon.

[2] Dr. A. L. Crelle's calculating tables giving the products of every two members from 1 to 1000 and their application to the multiplication and division of all numbers above one thousand. Revised by C. Bremiker. New York, Steckert.

The tables[3] before us, carefully designed as they are to meet the needs of a special group of students, are in a very different class. To workers in the difficult field of higher statistics such aids are invaluable. Their calculation and publication was, therefore, as inevitable as the steady progress of a method which brings within the grip of mathematical analysis the highly variable data of biological observation. The immediate cause for congratulation is, therefore, not that the tables have been done but that they have been done so well.

In the original prospectus of *Biometrika*, the editors promised to provide "numerical tables tending to reduce the labor of statistical arithmetic." Since 1901, when the first of these tables was published in *Biometrika*, the responsible editor has had but one end in view, the publication, as funds would permit, of as full a series of tables as possible.

A detailed list of the tables which have resulted from the grim perseverance in this determination for the past fifteen years is superfluous. Such fundamental series of constants as Sheppard's "Tables of the Probability Integral," Elderton's Tables of Values of P for Pearson's χ^2 Test of Goodness of Fit of Theory to Observation, Everitt's "Tables of the Tetrachoric Functions," Rhind's "Criteria for Frequency Types and Probable Errors of Frequency Constants," and such convenient aids to calculation as Miss Gibson's values of χ_1 and χ_2 and Soper's $1 - r^2$ to lighten the labor of the calculation of the probable errors are only sample titles of the fifty-five sets calculated by Bell, Duffell, Elderton, Everitt, Gibson, Greenwood, Heron, Lee, Pearson, Rhind, Sheppard, Soper, "Student" and Whitaker, which cover with great completeness the whole field of statistical description and analysis.

The convenient volume in which these are now brought together contains something over 75 pages of explanation and illustration and

[3] "Tables for Statisticians and Biometricians." Edited by Karl Pearson, F.R.S. Issued with assistance from the grant made by the Worshipful Company of Drapers to the Biometric Laboratory, University College, London. Cambridge University Press, 1914.

about twice that space of solid tables and diagrams. It has three noteworthy characteristics.

The first is the excessive labor involved in calculation. In a few instances, for example, in the case of the tables χ_1, χ_2 and $1-r^2$ to facilitate the calculation of the probable errors, it has been possible to arrive at constants of the greatest usefulness with a minimum of simple arithmetic. But in the great majority of cases, each entry has cost heavily. It is probably safe to say that the difficulties of computation have been far greater than in the majority of published tables.

The second remarkable feature of the book is originality of contents. For the most part, volumes of tables are largely made up of old material which has long since become common property. Practically, the whole of this quarto is strictly new. In only a few cases have materials already published been better adapted to meet the needs of statisticians. Thus the tables of logarithms of the Gamma function have been adapted from those of Legendre; the table of angles, arcs and decimals of degrees is based on Hutton's mathematical tables; after the table of logarithms of factorials had been completed, similar tables issued in 1824 were discovered and used as checks.

The third distinguishing feature of the volume is that it represents the work of a single laboratory and its associates under the leadership of the one who has finally brought the colossal undertaking to completion.

The cost of publication has been very great; it has been made possible only by distributing the expense of setting and moulding over a period of years of first publication in *Biometrika*. Thus the completion of the tables has largely depended upon the possibility of maintaining *Biometrika*. Though this has been given such protection as copyright affords, it has been practically impossible to prevent piracy of tables already issued and so to make possible the completion of the series. The editor remarks with a bitterness which is fully justified by his experience of the last few years: "It is a singular phase of modern science that it steals with a plagiaristic right hand while it stabs with a critical left."

The volume is indispensable to all who are engaged in serious statistical work.

J. ARTHUR HARRIS

Crystallography. An Outline of the Geometrical Properties of Crystals. By T. L. WALKER. New York, McGraw-Hill Book Co., 1914. Pp. xiv + 204, 213 figures in text.

So many elementary treatises on crystallography have appeared in the American press within the last five years that a new one would seem to be justified only by the introduction of some essentially new feature. Such a justification is certainly to be claimed for this brief work by Professor Walker in which a discussion of the geometrical properties of crystals is based on the gnomonic projection as employed in the methods of Goldschmidt.

After brief consideration of the process of crystallization in very elementary terms there is given in Chapter IV. an account of the gnomonic projection showing how by its means a graphic representation of the relations of crystal faces may be obtained; how numerical symbols for the forms and values for the axial elements may be read directly from it; and how the regular arrangement and spacing of the projection points illustrate the laws of symmetry, of constancy of crystal angles and of the rationality of parameters. The chapter also contains instructions for preparing both gnomonic and stereographic projections from two-circle goniometric measurements as well as an account of the conventional axes of reference and the derivation of Miller's index symbols.

This chapter seems to the reviewer an admirable presentation to the beginning student of the difficult subject of the mathematical relations of crystal faces. No adequate account of Goldschmidt's very useful methods exists elsewhere in the English language and these methods are here very happily welded to the conventional ones which they illuminate. It is to be regretted that the author did not supplement his account by a statement of Goldschmidt's energy theory of

the growing crystal with its simple expression in numerical symbols; and by a clear statement of the general reciprocal relation which exists between the polar elements of Goldschmidt and the linear elements of Miller.

The systematic description of crystal forms follows conventional lines, the concept of hemihedrism being used throughout to classify the various symmetry classes within each system. Chapters on twinning and on crystal drawing from gnomonic projection complete the author's text. A final chapter contains extracts from various American crystallographic publications which illustrate to the student the methods of procedure required for several varieties of crystallographic investigation. These extracts seem on the whole of doubtful value to the class of students for whom the book is primarily intended.

The illustrations include gnomonic projections of the holohedral class of each system. The crystal figures have suffered severely at the hands of the printer; a great number, nearly one third it seemed on a rapid estimate, are set skew on the page; figures 25 and 206 are inverted; and figure 161 is obscure. The text is free from such obvious results of careless proof-reading.

Charles Palache

Industrial and Commercial Geography. By J. Russell Smith. New York, Henry Holt & Co. 1913. Pp. xi + 914. 6 × 8¾ inches. Price $4.

The complex field of interests in which the student of industrial and commercial geography works, involves many matters which are not geographic, and many pitfalls are laid for the geographer who sets venturesome feet across its borders. Professor Smith has some freedom in working this field, since he comes to it as an economist, rather than as a geographer, and he has chosen "to interpret the earth in terms of its usefulness to humanity. And since the primary interest is humanity rather than parts of the earth's surface, the book deals with the human activities as affected by the earth, rather than with parts of the earth as they affect human activities." Thus the author frankly states his point of view, and as honestly does he carry it out through the 900 pages which follow. So the geographer has but one protest to make, and that is as to the choice of title. The work should have been called "A Text-book of Industry and Commerce" and it is in recognition of this point of view and purpose of the work, that this review is written.

The book is divided into two parts, Industrial Geography and Commercial Geography. In the first part there are essays on the changing forces in our environment; the place and nature of agriculture; on various industries and the commodities produced by them; on the fundamentals of manufacture; on the mineral industries and on the expansion of industries and resources. The second part of the book is given over to a statement of the principles underlying commerce; then to a sketch of the great highways of commerce, including the ocean, and trade routes of the various continents. The last four chapters are on the trade center; the balance of trade; and geographic influences in the commercial policy of nations.

The book makes interesting reading. One must admire the wealth of interacting relations presented by the author, even though he must at times take issue with the statement of fact or interpretation of the phenomena discussed. The style is frank and easy, often almost colloquial, quite unlike the usual text-book. In fact it will be criticized on this point as at times diffuse and in need of condensation.

Of course errors are bound to creep into any book. The most careful proof-reading will not avail against errors. But there are so many errors in this first edition as to make it seem that parts of it were overlooked in the proof reading. In the interest of accuracy it will be fair to call attention to some errors and inaccuracies. The author states, p. 46, that it is too cold for winter wheat north of Nebraska. Yet the record yield of wheat in America is held in eastern Montana, and with winter wheat. On p. 63 a wrong addition is made in footing up the world's wheat production; p. 75

the sense is spoiled by using run for rim; p. 92 the statement is made that corn has no gluten; p. 105 Austria is said to be in the Baltic basin; p. 106 Chile is given just one climate, the Mediterranean, and is said not to be hospitable to the potato, the country in which the potato originated; p. 119 Japan is credited with one sixth of her land under cultivation. The Japanese are much more modest in reporting the arable area; pp. 288 ff coffee, tea and cacao are treated as *condiments;* p. 292 ff San Domingo is wrongly used as the name of a country; p. 293 a wrong date is given for the abolition of slavery in Brazil; p. 296 Havre is given as the world's greatest coffee market; p. 307 diacritical marks are omitted from the Portuguese form of St. Thomas; p. 330 ff pilagic does duty for pelagic; p. 375 Maderia for Madeira; p. 378 ff the final letter is omitted from Pittsburgh; p. 378 steamboats are given credit for plying to Minneapolis; p. 403 has the great falls of Iguazu on the Parana River; p. 441 the form Austro-Hungary is used, and in another place Austro for Austria; p. 449 Estremaduro for Estramadura; p. 454 states that the Philippine forests belong to the United States government; p. 454 the Philippines are stated as "tree poor," an astonishing statement; p. 445 the tropical cedar used in making cigar boxes is said also to be used in making lead pencils; p. 498 we learn that "wool is covered with minute scales, whereas hair is smooth"; p. 584 Spain, etc., given credit as the source of most of our sulfur supply; p. 617 "plate glass . . . passed between rollers which give it the beautiful smooth surface"; p. 619 "the ancients were better artificers in copper than are the moderns"; p. 627 aluminum is said to be a more efficient "transmitter" of electricity than is copper; p. 637 a legend says "silver production is unusual in that it does not increase." The graph above the legend shows an increase from 72 to 220 in the period covered.

There are many examples of inaccuracy which may be due to loose writing. Such, for example, as p. 172, where the whole Parana valley is made a sheep district like that in Australia; p. 285 vacuum pans are used because there is *less* danger of burning; p. 311 vanilla "is an orchid-*like* vine"—but why continue? There are scores of these faults, little and big, which should not have gone out even in a first edition.

Such errors, while a serious blemish, are not permanent handicaps. Careful editing may remove them. The spirit of the author is so good, his interpretations so suggestive, that when a revision is made the book will stand as the best text-book presentation so far published in this country, of the complex and difficult field of industry and commerce, from the geographic viewpoint. The book can be used with advantage as a text in college classes, where the teacher, if a geographer, may easily accentuate to his taste the purely geographic elements involved.

J. PAUL GOODE

UNIVERSITY OF CHICAGO

THE COMMITTEE ON GENERAL SCIENCE OF THE NATIONAL EDUCATION ASSOCIATION

THE returns which have come in thus far indicate that the schools should give information from the whole field of science—not neglecting astronomy. The public needs unmistakably require a new organization of science instruction according to *projects.* The problems of life are not differentiated after the manner of specialized science. Pupils in both elementary and high schools are in a much more primitive state of mind in regard to all science than our school programs would indicate. Many are apparently blind and deaf to nature's most evident teachings. They are in the depths of superstition about common things even while surcharged with academic formulas regarding things scientific. Our secondary schools persist in articulating with that which is above them rather than with the elementary school. Few persons appear to know that they have the answers to most of their questions readily accessible in dictionaries, encyclopedias and readable books. Apparently we have deprecated the teaching of science from books too long and too success-

fully. The greatest need, and likewise the greatest demand, among even highly educated persons, is for *information* rather than *training* in science. All workers and students require training in their specialty, but in other fields they want knowledge in simple form and by the most direct method.

Natural science has moved from a position of great worth as a school subject to one of minor importance. Science teachers everywhere are beginning to regard it a high duty to bring it back to its rightful place and value. Attention has been too sharply focused on teaching "subjects" as against teaching students those things that are important for them to know. The schools reached the lowest point in real science instruction when, under the stress of preparing for higher institutions, they narrowed their work to "the forty quantitative experiments." It was desultory, scrappy, unorganized, unscientific. At best the teaching was confined to vocabularies of technical words, definitions of scientific terms, statements of "fundamental principles," etc. The natural and effective order is not principles followed by applications, but the reverse. From a multitude of experiences, facts and observations, arranged so as to illuminate one another, some few principles may be derived; if these principles can be shown to be fundamental and can be brought into immediate use. The trouble with most of the so-called "fundamental principles" is that they are never again met either in school or life, and the majority even of enlightened men get on very well without having ever heard of them, or, having heard, they have forgotten them because they did not prove to be fundamental to anything. A principle which occurs, or is likely to occur, so often that one can not forget it, is fundamental, and few others need be considered.

Principles are not to be taught merely for discipline and training, nor for use only in a remote future.

The study of "projects" in science will necessitate the breaking down of boundary fences that have been erected between highly specialized sciences.

General science should be adapted to local conditions and may not be universalized. Many projects elaborated by ingenious and skilled teachers should be published in a series of small books or pamphlets for the use of pupils. Teachers may select from these as time, place and other circumstances require. Enough of this material may easily be prepared to occupy many years of study on the part of pupils. What it is worth while to know from the fields of astronomy, botany, chemistry, geology, meteorology, physics, physiology, zoology, etc., may be thus acquired.

Correspondence is invited.

John F. Woodhull,
Chairman

Columbia University,
New York City

INDIANA UNIVERSITY EXPEDITIONS TO NORTHWESTERN SOUTH AMERICA

In these columns in 1905, Dr. C. H. Eigenmann gave a discussion of the fresh-water fishes known from both slopes of Panama,[1] and suggested the advisability of a biological survey to record their distribution before the completion of the canal should furnish a waterway and allow the intermingling of the two faunas. His conclusions were, in the main, that the Pacific slope fauna was derived from the Atlantic slope fauna in times more recent than the obliteration of the interoceanic connection, and that this fauna crossed the divide somewhere near Panama. At his suggestion, resolutions were adopted by various scientific bodies, including the International Zoological Congress and the American Association for the Advancement of Science, calling upon the president and congress to provide means for a survey of the regions about the canal. In 1910, under the auspices of the Smithsonian Institution, the survey was organized from among the various scientific departments at Washington. The collection of fishes was intrusted to Dr. S. E. Meek, of the Field Museum of Natural History, and Mr. S. F. Hildebrand,

[1] Science, N. S., Vol. XXII., No. 549, 1905, p. 18.

of the U. S. Bureau of Fisheries. They spent the winters of 1910 and 1911 in the field, but their results remain largely unpublished.

In December, 1911, Professor Eigenmann left for Colombia with the principal object of investigating the faunas of the Atrato and San Juan Rivers, south of Panama. These rivers flow in opposite directions in a longitudinal trough west of the Western Cordilleras and the height of the divide between them does not much exceed 300 feet. Other points were the relation of the faunas of the Atrato and the Magdalena, which seemingly possess no obstacles to inter-migration, and the relationship existing between the faunas of the upper Cauca and the upper Magdalena, separated as they are by the high Central Cordilleras. Dr. Eigenmann landed at Cartagena and proceeded thence by river steamer and rail up the Magdalena, collecting en route at Puerto Wilches, Peñas Blancas, Honda and Girardot, thence to the high plateau of Bogota, where a large collection was made of all fishes occurring there, including the supposedly mutating "capitan" (*Eremophilus mutisii*). He then proceeded by pack-train from Girardot through Ibagué and Toche, crossing the Central Cordilleras over the Quindío pass, descending thence to the Cauca at Cartago, from which point he continued by pack-train to Cali, collecting on the way. With more pack mules the Western Cordilleras were crossed to Caldas; from here collections were made at successively lower elevations on the River Dagua to the coast at Buenaventura. From this point a steamer carried the expedition up the San Juan to the head of navigation at Puerto Negria, thence a dugout continued on to Istmina. The low continental divide was crossed here to the Atrato; he went then by steamer to Cartagena. Collections were made at various points along these rivers. Dr. Eigenmann returned to the university in the middle of April, 1912. The expenses of this expedition were assumed by the Carnegie Museum of Pittsburgh, to which belongs the first series of the fishes collected; the second series remains at Indiana University.

Since his return, Mr. Manuel Gonzalez, a Colombian, who accompanied him on part of the trip, has been employed by the university to continue collecting about Bogota and to the eastward in the headwaters of the Orinoco.

Mr. Charles E. Wilson, an Indiana University student, left in December, 1912, for Tumaco, the most southerly port of Colombia on the Pacific. He spent about a month collecting in coastal streams and above Barbacoas in the Telembi, a tributary of the Patia. He then continued northward to Buenaventura, returning over the San Juan-Atrato route, collecting at various points in both of these rivers and in the Truando, one of the principal tributaries of the Atrato. He returned to the university in April, 1913. His expenses were paid by Mr. H. McK. Landon and Mr. Carl G. Fisher, both of Indianapolis.

Mr. Arthur W. Henn, another student of the university, had been with Mr. Wilson on the Telembi when both were forced to return to Tumaco with fever. When recovered Mr. Henn returned to Barbacoas by small steamer and then went by pack-train to Tuquerres, situated in the Western Cordilleras at an elevation of over 10,000 feet. From here, after some delay, he continued northward with another specially engaged pack-train to the gorge of the Patia, where this mighty stream has cloven a majestic canyon through the Western Cordilleras. The route followed here was in general that followed by the geologist A. Stübel through Ancuya, Tambo and Peñol. The gorge was reached at the mouth of the Guaitara. The expedition continued back through Pasto and Tuquerres to Barbacoas and Tumaco. Mr. Henn sailed then for Buenaventura, continued to Puerto Negria by small steamer, and returned by canoe to the lower San Juan, especially for work in the Calima, which he ascended for three days, returning overland to Buenaventura. Instructions had meanwhile been received from Dean Eigenmann directing the work to Ecuador.

Mr. Henn sailed southward to Guayaquil, where he arrived in May. A short trip was taken to Naranjito, where collecting was done in the River Chan Chan. He then went to Manabi, entering at Bahia, fishing at Chone

and Portoviejo and returning to Guayaquil by way of Manta. Several more weeks were spent in the rivers Daule and Vinces. He then ascended into the high Andean plateau over the Guayaquil and Quito Railway, collecting at various points. From Quito he descended again into the subtropical forest region at Mindo on the western slopes of Mt. Pichincha. The expedition then continued northward to El Angel, where several weeks were employed excavating old Inca tombs. Nearly 300 pieces of Inca pottery were obtained; these are now in the John Herron Art Institute of Indianapolis and the Carnegie Museum. Mr. Henn went from here down the valley of the Chota to a point below the hacienda Paramba.

Revolutionary developments and the presence of roving bands of "montoneros" made necessary a return to Quito, where the month of January was spent. Here a small collection of birds, aggregating about 65 species, was obtained, chiefly from Pichincha and the surrounding region. When quiet again prevailed, Mr. Henn returned to El Angel to secure the stored collections, continued on through Tulcan to the Colombian frontier and thence to Barbacoas, reached after twelve days of continuous travel by mule from Quito. He arrived in New York at the end of March of this year after fifteen months in the field. Aside from the collections of fishes, the collection of batrachians comprises probably 400 specimens, representing all ranges of altitude and climate. The collection of mammals is insignificant, of note is the acquisition of four skulls and one skin of the rare spectacled bear (*Tremarctos ornatus*). This expedition was made possible by the generosity of Mr. Hugh McK. Landon, of Indianapolis.

The general result of these expeditions is the definition of two geographical sub-provinces, of more or less equal value, differing somewhat in their constitution, but more so in their origin. The Pacific Province of continental South America may be divided into two sub-provinces, (1) the Colombian, extending from the Chepo basin of Panama south to the river of Esmeraldas and (2) the Ecuadorian, extending from the Guayas system south until lost, probably in the desert of Atacames. The fishes of the Pacific slope are in general widely distributed Amazonian types; none of them would cause surprise if taken at Manaos.

The Colombian sub-province is characterized by its extreme humidity. None of its rivers are large, the San Juan and Patia are the largest, but all carry a relatively immense amount of water. The few fishes which have come into them have undergone much adaptive radiation. Its fauna is much richer than that of the Ecuadorian sub-province. Its types are mostly Amazonian and among the oldest found on the continent. This fauna has certainly entered over the Atrato-San Juan route. The fishes of these two rivers are very similar and many species are common to both. The channel-fishes of the Atrato, however, have not succeeded in crossing over to the San Juan. They have spread thence to all the rivers south to Esmeraldas. Those of the Chepo and Tuyra basins of Panama have evidently also come from the Atrato. Dr. Meek says:[2]

> . . . it is quite evident that strictly South American migrants in comparatively recent times did not go far beyond the Canal Zone, and that most of these are lowland forms which came from the streams on the Atlantic side of Colombia to the Pacific side after the last gap (Atrato-Tuyra) here between the two oceans was closed. We find *Curimatus, Ctenolucius* and *Gasteropelecus* and other Colombian Atlantic forms in streams opposite the Rio Chagres but not in it. Some Loricarids occur in these streams and also in the Rio Chagres, but these appear to us to have probably crossed from the Pacific side streams to the Chagres and not to have migrated from the rivers of Colombia to the Chagres direct.

The Ecuadorian sub-province is characterized by its increasing aridity, which begins immediately south of the cross-ridge of Esmeraldas, is intensified below Guayaquil as shown by the Desert of Tumbez, and culminates in the desert regions of Peru. In the long dry season all of the rivers dwindle to mere puddles. Under these unfavorable conditions

[2] Publications, Field Museum of Natural History, Zoological Series, Vol. X., No. 10, 1914, p. 134.

but little evolution has taken place. The difference from the fauna to the north is the difference in species; the genera are in most cases of wide distribution.

Few species occur in both faunas, and these are such widely distributed barrier-surmounting fishes as *Rhamdia, Hoplias* and *Lebiasina*. For them the Esmeraldas ridge has not been a barrier. *Sternopygus macrurus* may have come from the north; it is the only Gymnotid found south of Esmeraldas. Sub-andine forms also occur indiscriminately in both regions. The four distinctive Pacific-slope genera are confined to this region. It is a very old fauna and an extremely meager one. *Astyanax festæ, Astyanax* or *Bryconamericus brevirostris* and *Bryconamericus peruanus,* all lowland forms, confined to this area are more intimately related among themselves than they are to the nearest geographical members of their respective genera. Either long isolation in a region offering few environmental units has caused them to converge or they have only recently arisen.

This fauna has evidently come from the east coincident with the first stages in the rise of the Andes. This possibility was suggested by Dr. Eigenmann[3] in 1909, chiefly to account for the presence of *Cetopsis occidentalis* which has near relatives in the Upper Amazon. A ridge or spur of the Andes forms the watershed between the systems of the Esmeraldas and the Guayas. On it is situated Santo Domingo de los Colorados at an elevation of 1,500 feet, but its height nearer the sea is further decreased. This seems to separate the two faunas. It is, according to Wolf,[4] of early tertiary formation and probably arose but slightly later than the beginning of the upheaval of the great western chain. The trough in which now flow the Guayas and the Daule is of subsequent alluvial formation. Deposits showing tertiary depression occur at Loja and in the headwaters of the Catamayo. Through this route possibly have entered the fishes. This point now raised more than seven thousand feet above the sea is, however, the only break in the majestic wall of the Andes.

"The distribution of the *Glandulicaudinæ* shows a strange relationship between the faunas of Transandean Colombia and southeastern Brazil. This relationship is confirmed by the distribution of *Salminus* and other fishes. The similarity is not confined to positive resemblances, but a number of types absent from northwestern Colombia are also absent from southeastern Brazil and Uruguay.

"The few genera of small fishes which succeeded in crossing or circumventing the Eastern Cordilleras of Venezuela and Colombia have undergone a remarkable radiation in Colombia. These Cordilleras very probably become a barrier before the evolution of the electric-eel, the Serrasalmoninæ and many others of the common Amazonian sub-families which are absent from Colombia. This makes very desirable a knowledge of the fauna of the region about Lake Maracaibo, where the university later plans to send an expedition."

The factors of vertical distribution are to be considered in a region so mountainous as that contiguous to the Andes. Of interest here is the *recurrence* of the same species at similar altitudes, in widely separated localities, a fact pointed out by Sir Edward Whymper among insects. The same species of *Hemibrycon* was taken at Sandoná, in the Pacific slope of the Western Cordilleras; at Ibagué in the Central Cordilleras and at Guadual, in the Atlantic slope of the Cordilleras east of Bogota, in each case at an elevation of some four thousand feet. *Bryconamericus caucanus* occurs in the Upper Cauca and at a similar altitude in the Upper Patia. *Arges cyclopium* occurs in all the high inter-andean valleys of Ecuador and is represented at Toche in the Central Cordilleras nearly four hundred miles to the north by a very similar if not identical form. This species, known as "Humboldt's fireproof fish" is the only true andean fish; in the great Andes of Ecuador it ranges as high as eleven thousand feet.

At elevations not greater than five thousand feet, a subandine fauna is encountered containing fishes such as *Pygidium, Arges, Hemibrycon, Rhoadsia* and *Piabucina*. The number

[3] Reports of the Princeton University Expeditions to Patagonia, Vol. III., 1909, p. 361.

[4] "Geografia y Geologia del Ecuador," Leipzig, 1892.

of species here is in direct proportion to the amount of rainfall. The stream gradient at this altitude is very high, but great humidity permits standing pools of water outside of the rivers themselves. Full tables of the distribution of the fishes of Colombia and Ecuador will be given in the final complete reports.

Arthur Henn

SPECIAL ARTICLES

POSSIBLE FACTORS IN THE VARIATIONS OF THE EARTH'S MAGNETIC FIELD

Newall[1] has described a very interesting experiment in which "a lamp flame held under an iron or steel wire (which is in circuit with a galvanometer), so that a short portion of the wire becomes red hot, is made to travel slowly under the wire, and it is found that a current appears in the galvanometer, the direction of the current depending on the direction in which the flame travels. Tomlinson[2] described a similar experiment at an earlier date than Newall. While this current is described as due to difference in thermo-electric quality between the iron or steel in the magnetic and non-magnetic state, yet it is suggestive of what might happen in the crust of the earth as the sun's rays fall upon its surface and warm it.

The following simple experiments were carried out with a view to getting more light on the phenomenon of earth currents and their relation to the earth's magnetic field. A board, seventy-five centimeters long and four centimeters wide, Fig. 1, had a shallow rim fastened around it so as to form a tray. At either end was fastened a zinc strip, both of which were in turn soldered to copper wires leading to a galvanometer. In this tray and covering the zinc terminals, a fairly homogeneous paste of mud was placed about one half centimeter thick. The water used in making up the mud paste was slightly acidulated with sulphuric acid to make it a better conductor. When a Bunsen flame was allowed to play on this strip of mud for some little time and then slowly moved in one or the other direction lengthwise of the tray, a current was set up in the galvanometer, depending upon the direction of the motion of the flame.

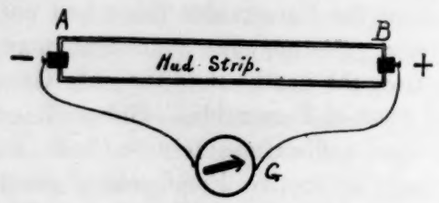

Fig. 1

If the electrode marked *B*, Fig. 1, was made positive by applying the positive pole of a dry cell to it and the negative pole to *A*, then the galvanometer gave a deflection to the left. When the flame was slowly moved from *A* toward *B*, the deflection of the galvanometer was to the right, and when the motion of the flame was reversed the current was also. This indicated that the direction of the current was opposite to that of the burner.

Suppose now this condition exists in the surface of the rotating earth as the heat rays of the sun falling upon it move from east to west. A current will be set up in the opposite direction, *i. e.*, from west to east, which will locally complete itself on the earth's surface somewhat as shown in Fig. 2.

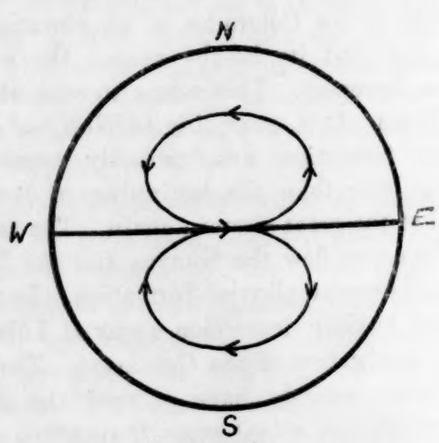

Fig. 2

It was found that the hotter the Bunsen flame for a given rate of moving, the greater

[1] Newall, *Philosophical Magazine*, June, 1888. See also Ewing's "Magnetic Induction," p. 184, 3d ed.

[2] Tomlinson, *Philosophical Magazine*, January, 1888, p. 50.

the deflection of the galvanometer. Hence we would expect that the maximum current density would be set up in the earth's crust, most directly under the sun and parallel with the equator. Consequently the resultant of all of the current filaments set up in the earth's crust would be represented by Fig. 2, in which the currents in the southern hemisphere would be opposite to that in the northern.

As this current sheet advances westward with the sun, and its magnetic field strikes the various magnetometer needles, there will be the conditions for a westward deflection in the northern hemisphere and an eastward deflection in the southern hemisphere, followed later in the day by a reversed deflection in both cases.

This experiment on the mud strip was repeated and the same results obtained with several kinds of soil to be found here locally. The relation of direction of current and direction of motion of flame was the same for the mud strip as for the iron wire investigated by Tomlinson.[2] From what we know of thermo-electric elements, it would seem possible to find conditions where the direction of the current would be the same as the flame. For instance, in large areas covered by glacial deposits if one edge of the deposit was heated more than the opposite edge we might possibly find a condition as just stated. Certain it is that oceanic areas would differ from land areas for these thermo-electric earth currents.

It was interesting to note the effect of pouring water on the strip of mud. Fairly large disturbances were produced when one or the other edge of the wet portion was heated. Local showers might thus produce local magnetic disturbances.

Blowing air either on one side or the other of a heated section of the strip also produced regular disturbances. Winds in this respect may be a possible cause of magnetic disturbances.

The cooling effect of a cloud passing over the sun or the shadow of the moon sweeping across the earth's surface in an eclipse may be made manifest by setting up these thermo-electric currents which will affect the earth's magnetic field. The temperature to which the mud was heated was bearable to the hand.

Whether these thermo-electric currents actually exist in the earth's crust as due to the heat of the sun's rays, and whether they could be picked out from other earth currents, is a matter to be investigated further, but for the present it does seem worth while to learn more about these thermo-electric currents due to a moving heat source or sink in all sorts of conductors, particularly electrolytic.

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CHANGES OF DRAINAGE IN OHIO

THERE is probably no state in the union in which the advance of the ice caused more decided and interesting changes in drainage than Ohio. Almost every stream of any importance in the state is now running in a new channel for at least a part of its course, and most of them for practically their entire distance.

During the progress of the reconnaissance soil survey of Ohio the writer had an opportunity to visit every section of the state and to make some study of the adjustments in drainage which resulted from the advance of the ice. Some observations and conclusions are believed to be of general interest and may be of value in interpreting changes in drainage elsewhere.

The most important relates to the probable interglacial rather than preglacial origin of many old valleys in Ohio, but the gravelly nature of all terraces along streams in or issuing from the glaciated section of the state, as contrasted with the silt and clay character of the terraces along nonglacial streams, is also worthy of mention, as this fact often helps to determine the age as well as the direction of flow of some old streams.

The course of the old Kanawha River was definitely traced many years ago through the hills east of the Scioto in southern Ohio as far north as Waverly, but as to its further course there has been some doubt. The occurrence of deposits, similar to those in its old

channel, upon the west side of the Scioto northeastward from Waverly and the presence of an old valley extending on for several miles beyond Richmondale, carrying like material, and finally turning westward to the Scioto again below Chillicothe (see Waverly and Chillicothe topographic sheets) proves conclusively that the old Kanawha flowed northward as far as Chillicothe. It seems very probable that it also extended northward through the present Scioto Valley to the vicinity of Marion and then possibly on northward into Lake Erie.

It will be recalled by those familiar with the topography of Ohio that the highest point in the state is near Bellefontaine in Logan County. Although the rocks in this section dip to the southeast the hills east of Bellefontaine are capped with the same formations that are found around Delaware, although the latter is approximately 40 miles east and 600 feet lower in elevation. The large amount of erosion which has been necessary to the formation of the Scioto Valley would seem to indicate very strongly the continuance of the old Kanawha northward.

It has been shown by Tight[1] that an old valley leaves the Scioto about halfway between Columbus and Circleville and extends northeastward by Buckeye Lake and Newark to the Muskingum at Dresden. From this point the valley extends on northeastward up the Muskingum and Tuscarawas to Canal Dover and thence on northward by Beach City and Justus to Massillon. Beyond this point its course is rather difficult to determine because of the deep drift and possibly for other reasons which will be evident later.

This valley has been considered as a possible channel of the old Kanawha River although Leverett[2] states that he has "found decisive evidence against the suggested northeastward line, in the presence of an old divide now crossed by the Tuscarawas between Zoar and Canal Dover." He apparently rejects the northward extension of the old valley suggested above because of a restriction in width near Strasburg. However, the narrowest place is almost one half mile in width (about 2,300 feet), or wider than many places along the Ohio River to-day, and the restriction is believed to be due to the character of the rock. Almost as narrow a restriction occurs just north of Conesville (see Navarre, Canal Dover and Conesville topographic sheets). A rather careful study during last summer convinced the writer that the Tuscarawas from Navarre to Canal Dover was deflected by the Wisconsin glaciation and that the present course by Zoar and across the divide to Canal Dover was opened up during this time.

While the writer does not believe that this old valley was ever occupied by the Kanawha, this opinion is based upon other evidence than the presence of the divide near Canal Dover. It is believed that this old valley, as well as many others in Ohio, is of *interglacial* origin while the Kanawha is *preglacial*. Some of the reasons for this conclusion will be briefly presented.

From Chillicothe southward the Scioto River has a very much wider valley than the Hocking, Muskingum, or even the Ohio in much of its course. In fact these streams have practically no bottom lands. The Scioto Valley was evidently formed after the change in the Kanawha drainage because it is 100 feet or more lower than the old Kanawha Valley and therefore could not have been carved out by a northward flowing stream. It, therefore, becomes necessary to explain the greater width of this valley as compared with the valleys of the other streams. The most satisfactory explanation seems to be that during interglacial time this valley formed the line of discharge for all of the drainage northeastward, at least as far as the Tuscarawas drainage now extends, and it may be possible that the first change in the Ohio drainage was also across the divide between Canton and Alliance and down this valley. The elevation here, with the drift added, is hardly equal to that of the hills near New Martinsville and, if the advance of the ice, which first obstructed the northward Ohio drainage, did not come as

[1] *Bull. Dennison University*, Vol. VIII., Pt. II., 1894, pp. 35–61.

[2] Mon. 41, U. S. Geol. Survey, p. 103.

far south as Alliance, which seems very probable, the Ohio might easily have first broken over here and have flowed westward.[3] The deep drift in this section makes it difficult to determine this point but the width of the Tuscarawas Valley, the narrowness of the present Ohio Valley and the occurrence of lacustrine deposits north of Alliance and mixed more or less with the drift in many parts of the Grand River Valley seem to strongly favor such an hypothesis.

It is generally believed by geologists that the preglacial divide of the Ohio drainage was near New Martinsville, West Virginia. A study of the direction of the streams along the Tuscarawas would seem to indicate that the preglacial divide along this stream was near Port Washington and that Big Stillwater, Conotton and Big Sandy Creeks flowed northwest, the former by Canal Dover along the present course of Sugar Creek reversed at least beyond Beach City. Whether this stream joined the other two near Justus or Navarre or flowed on northwest separately can not be stated definitely because of the drift and the changes brought about by the advance of the ice. Below Port Washington the drainage was probably westward into the Scioto Valley and old Kanawha system.

Upon the first advance of the ice southward of Lake Erie the drainage of all northward flowing streams was obstructed and it became necessary for their waters to seek other outlets. As the country to the west was in general lower the streams were dammed up until they finally ran over the lowest divide on the west. There was a tendency for them to follow in a general way the ice border, just as the Ohio and Missouri Rivers to-day follow rather closely around the southern extension of the ice.

In view of the above considerations it is believed that the Tuscarawas-Scioto Valley had its origin in an early advance of the ice and represents the principal drainage line during interglacial time, and that the advance of the ice farther southward during the later glaciations forced the Hocking, Muskingum and possibly the Upper Ohio to change to their present channels. Such a hypothesis makes it possible to explain many very peculiar connections between old valleys, which are very difficult to understand otherwise. If the time which elapsed between the different advances of the ice, had been estimated with any degree of approximation it can be easily understood how much larger valleys may have been formed during interglacial periods than since. The matter appears to deserve more consideration in the interpretation of changes of drainage than it has been given heretofore.

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[3] Since this article was written the writer has had an opportunity to make further observations in the country north of Alliance and has found further evidence, particularly an old valley near Ravenna, to substantiate the hypothesis that the Ohio River first broke over in this section and formed the Tuscarawas-Scioto Valley.

THE POISONOUS NATURE OF THE STINGING HAIRS OF JATROPHA URENS

Jatropha urens is one of the most abundant Euphorbiaceous plants growing in or around the savannas of the Pacific coast of Central America. Its spread is favored by the fact that the cattle avoid it, and because it is not kept down by the too indolent owners of the pastures. Everywhere it has the reputation of being extremely dangerous, on account of its poisonous effects.

The plant is easily recognized: It is herbaceous, 0.5 to 1.5 meter high, regularly ramified, with large palmatilobate leaves, white flowers and small, 3-celled capsules. All parts, trunk, leaves, flowers and fruits are covered with long, hard and glossy, stinging hairs, which protect the plant as barbed wire protects the fortifications of to-day. It would seem as if the remarkable glossiness of the stinging hairs might warn the curious against approaching or touching. As a mater of fact, the animals either by instinct, or on account of the wisdom acquired through some previous experience, avoid contact with it.

The vernacular name of *Jatropha urens* is "ortiga" or "ortiga brava" (nettle) in Panama, and other parts of Central America, in-

dicating somewhat its noxious effects. Sometimes it is also called "chichicaste."

The stinging hairs of *Jatropha urens* show the same structure as those of the common nettle (Urticaceæ), though the two plants belong to different families. The poison is produced by a cell of the epidermis which, during the growth, swells up, forming a goblet-shaped bulb, set into the surrounding tissue. The hair then represents a long tube, the walls of which have incrustations of silicic acid in the upper part and are calcified in the lower parts, so that they are very brittle and break at the lightest touch. Near the top this cell expands a little, in the form of a miniature hat with very thin walls, so that when touched, it breaks in an oblique direction, forming the point of a cannula, which enters the skin of animal or man. At the same time the poisonous liquid of the cell is discharged into the wound, and produces instantly a local inflammation. The mechanism is, in fact, the same as that of the poison fang of the snakes, and it is also similar to the cannula of the surgeon.

To estimate the formidable effects of the hair and the intensity of its poisonous liquids, it has been calculated that about 10,000 hairs of the common nettle may produce one drop of poison (0.05 c.cm.). As in the case I am going to mention, about 10 hairs of the *Jatropha* were broken. It may be calculated on the same basis that about 0.00005 c.cm. of poison entered the wound. This is, however, a low estimate, because the hairs of our plant and their inner cavity are larger than those of the common nettle and the amount of poison introduced into the system in the following occurrence was probably much larger than it would have been in the case of an equal contact with *Urtica urens*.

On an excursion along the San Felix River, in eastern Chiriqui, with Dr. MacDonald, geologist of the Canal Commission, the writer became acquainted with *Jatropha urens* by unavoidable contact with a single specimen of the plant. All at once he felt an intense burning on the left hand, where about 10 of the stinging hairs had entered pretty deep into the skin. The inflammation produced by this touch was very similar to that produced by nettles, but the pain soon increased, the whole hand began to swell and inside of half an hour had assumed a monstrous shape. Then the arm commenced to swell also, the right hand and arm, without having been innoculated, yet showed the same abnormal symptoms, and a very strong itching sensation was felt all over the upper part of the body. At about the same time parts of the face, around the eyes and nose, swelled considerably. The itching sensation rapidly spread over the abdomen and the lower extremities and red pimples appeared everywhere. In less than an hour the poison had extended over the whole surface of the body, and its entrance into the blood current was indicated by the corresponding physiological reaction of the interior organs. The palpitation of the heart became extremely accelerated and the mind was soon overcome by an agonizing depression. The respiration seemed to be delayed as if under a great pressure, cold sweat broke out, and the patient gave way altogether, remaining unconscious for more than an hour, except for feverish dreams. After coming back to his senses, he had several fits of copious vomiting, from which it may be surmised that the poison was slowly eliminated from the organism. The weakness, however, remained for several days.

A case of such extreme effects, which might have killed a man of less strength than the writer, has never been recorded, as far as the literature on the subject shows. Undoubtedly the intensity of the intoxication was due to the rather strong contact with the plant, which caused a considerable amount of poison to be introduced into the blood circulation.

Many other tropical plants, among them some *Urticaceæ* and *Loasaceæ*, have such deadly stinging hairs, the poison of which is active enough to kill a man, even in a relatively small dose. The only way of allaying its effects would be to neutralize or precipitate it by means of a prompt application of chloride of lime, ammonia or sodium permanganate.

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